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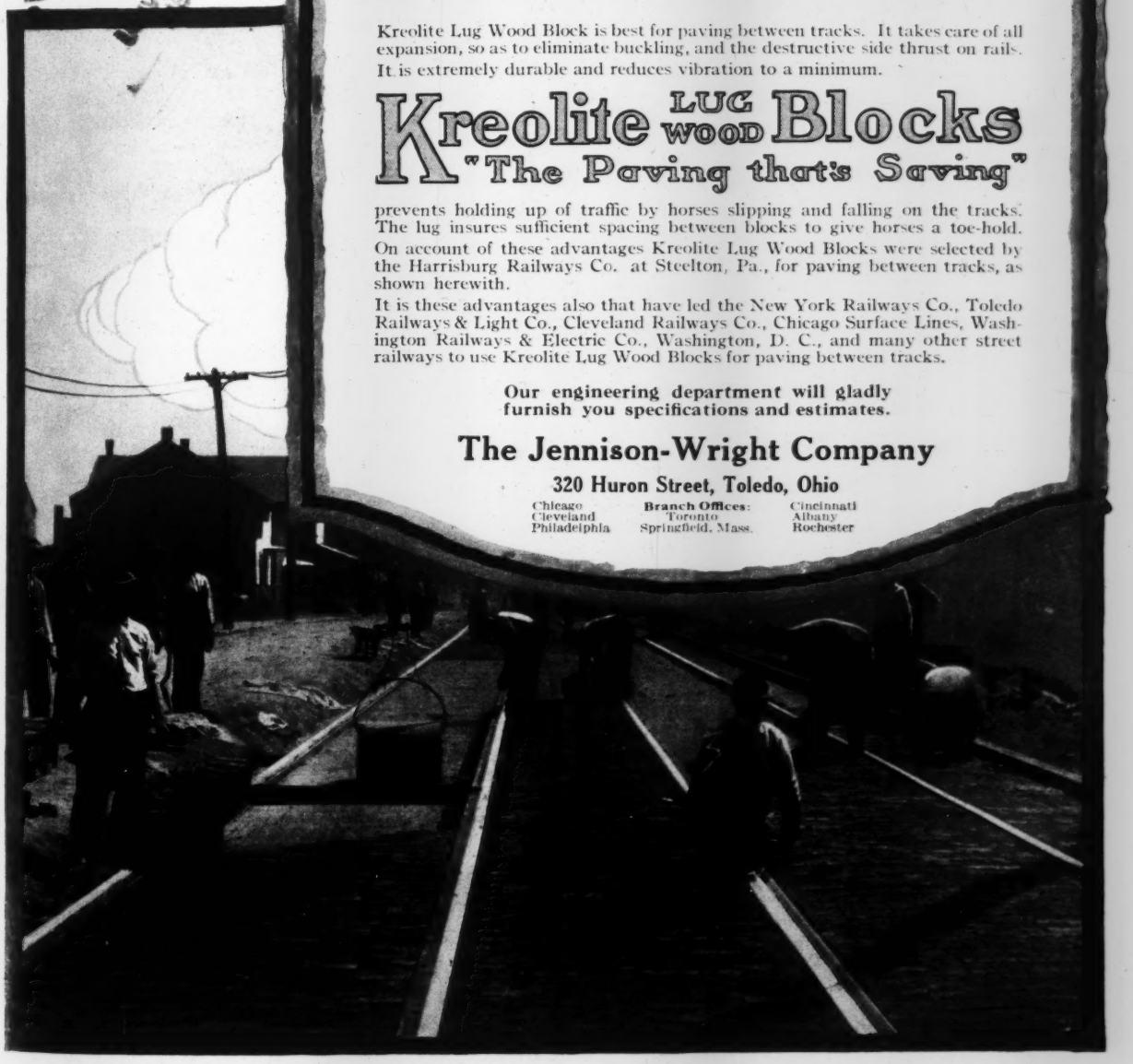

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prevents holding up of traffic by horses slipping and falling on the tracks. The lug insures sufficient spacing between blocks to give horses a toe-hold.

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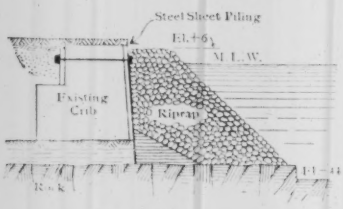
The straight line single wall of Lackawanna Steel Sheet Piling forming the north side of the 46th street cofferdam, New York.

The north side of the cofferdam was largely in shallow water and most of the way extended along an existing crib, so that at this location a straight single line of Lackawanna Steel Sheet Piling joined to the old crib was figured to have ample strength and watertightness to meet all requirements.



Accordingly, the special steel sheet piling section at the inner corner of the first cell, as shown above, was utilized for attaching the straight wall.

The single wall of steel sheet piling is tied back to the crib with 3-inch tie rods horizontally placed above low water as shown in the sketch. One end of each rod has a nut and washer bearing on the steel ranger (two 15-in. channels 40-lb.) inside the cofferdam and the other end has a similar bearing on a chock across the faces of two anchor piles driven in the adjacent crib pier.

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Engineering News

VOLUME 75 MARCH 16, 1916 NUMBER 11

Brooklyn-Brighton Concrete Viaduct Completed

By W. H. Baker*

As stated in *Engineering News* of Sept. 9, 1915, the Brooklyn-Brighton viaduct was expected to carry traffic by the middle of August, 1915. Several influences, including the weather, worked against this expectation.

After the last section of the floor on the west half was poured on July 21, the entire floor was cleaned and all expansion joints made ready for the waterproofing, which was begun at the south end, July 26. During the ensuing week constant showers prevented much progress with this part of the work. However, enough was satisfactorily completed to permit the Cleveland Railway Co. to begin laying its track at the south end on Aug. 2. By Aug. 15 the entire west half was waterproofed and the railway track concreted in. The track consists of 95-lb. T-rail laid on Carnegie steel ties, Section M25, with concrete poured over the ties and the base of the rail to the level of the high points on the roadway concrete.

A 15-in. concrete curb, protected with Kahn curb bars, was built the entire length of the bridge. At the extreme right of the view, Fig. 3, reinforcing bars are seen projecting up from the concrete of the floor; later a similar row was built into the concrete of the east half. The "middle curb," which separates the two roadways of the bridge, was built around these bars, usually the next day after completing the floor. Two-inch forms were used, with 2x6-in. studs at close intervals, and a very attractive job was obtained. Fig. 3 also shows old ties placed longitudinally along the inside rail. They kept the concrete base of the track away from the space required for construction of the middle curb.

When the concrete for the west half was poured, wooden cores were placed at the middle of all floor-beams that would finally carry a trolley pole. Before the east half was poured, these cores were removed and sections of 10-in. steel pipe put in. Four ¾-in. bolts held these pipes in position until the concrete was all placed. Fig. 3 shows the trolley poles in place, set in the steel collars.

After the middle curb was finished, the trolley poles were plumbed, and the ¼-in. joint between the poles and the 10-in. collars was filled with sand to within 1 in. of the top. This inch allowed the joint to be sealed with

*Resident Engineer on Brooklyn-Brighton viaduct for Cuyahoga County; Court House, Cleveland, Ohio.

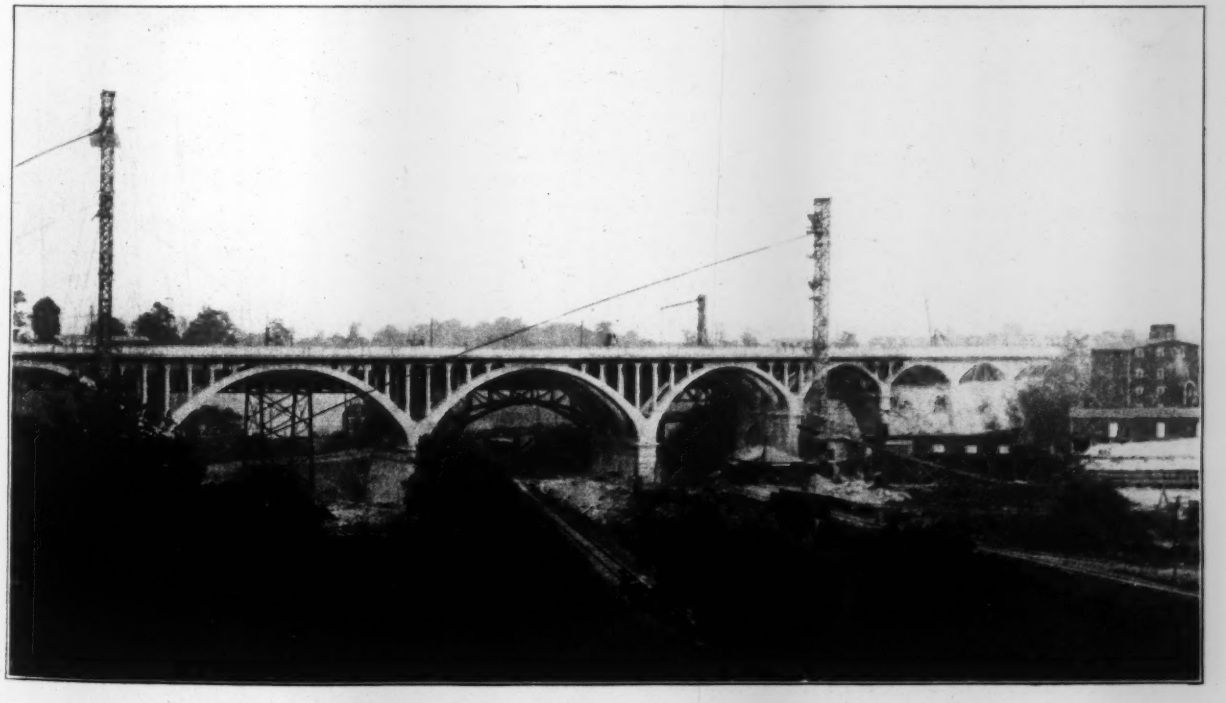


FIG. 1. A SECTION OF THE BROOKLYN-BRIGHTON VIADUCT, PARTLY BUILT
View of the whole bridge after completion is shown on the next page

FIG. 2. EAST SIDE OF COMPLETED BROOKLYN-BRIGHTON VIADUCT.
The site of the old steel viaduct

grout; then a coat of black paint gave the base of the trolley poles a uniform appearance.

Pace Bros., Cleveland, began paving the west half of the bridge, Aug. 20, and finished grouting at 11:30 p.m., Aug. 25. The paving was granite block laid on a 1½-in. cement-sand cushion. After the blocks were laid and rammed, the surface was thoroughly flushed. The grout was immediately applied and worked in with brushes. Materials for paving were handled over a small track laid on the sidewalk (see Fig. 3).

The curb is of granite; the back face had a projection ¾ in. wide, to fit a recess molded in the vertical face of the concrete curb. The west halves of the north and south approaches were macadamized with 8 in. of slag below the subgrade of the final paving.

FIG. 3. PAVING WEST HALF (LOOKING NORTH ALONG ROADWAY, AUG. 24, 1915)

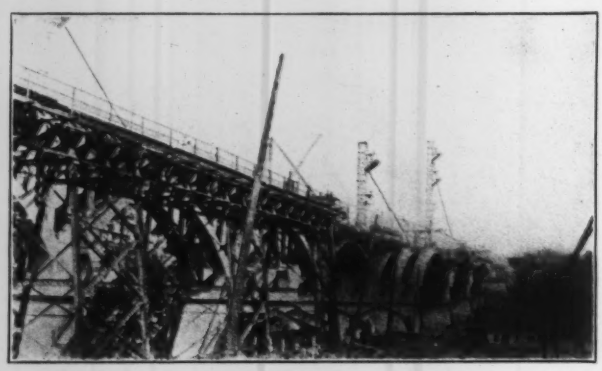


FIG. 4. STARTING WORK ON EAST HALF (NORTH PORTION OF STEEL VIADUCT RAZED)

On Aug. 26, the pavement being finished, all street-car traffic was carried by the new viaduct. Vehicle traffic was diverted in order to commence razing the old steel bridge. This traffic was not permitted on the new pavement until ten days after completion of the grouting.

Bates & Rogers Construction Co. started burning down the old bridge on Aug. 26. This work was done with the oxyacetylene flame and was continuously prosecuted, night and day, until Sept. 16, 1915. On this date, when 830 tons, or 75%, of the old viaduct had been removed, a point was reached such that the old bridge no longer interfered with the construction of the new viaduct. The razing of the old bridge was then delayed until later, and the last piece was taken away Nov. 22, 1915. Fig. 4 shows the work when the razing of the old bridge was stopped and the construction of the east half started.

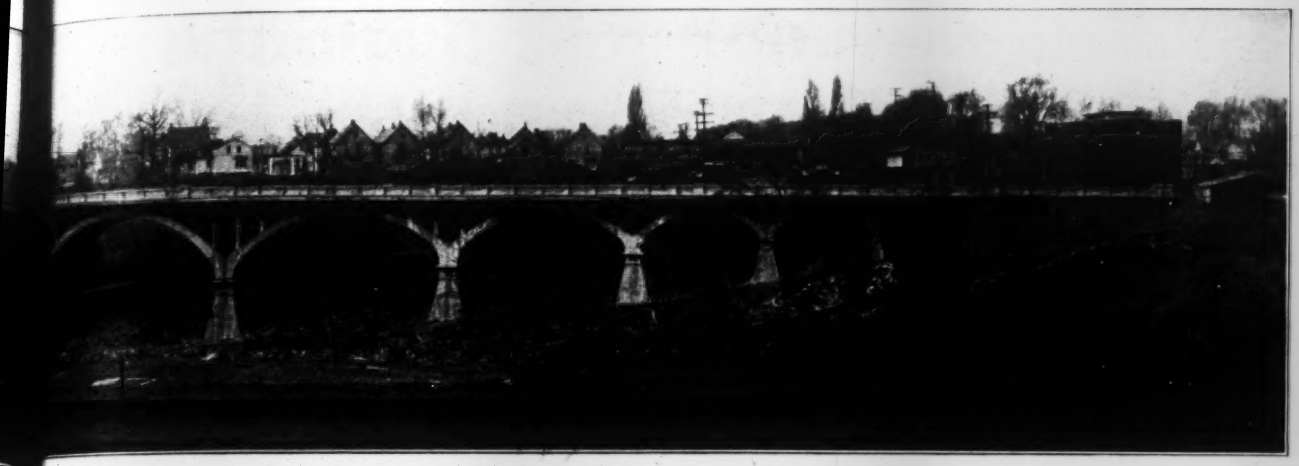
About 2,700 cu.yd. of concrete was poured between Aug. 26 and Sept. 16. The last section of floor was placed Nov. 4, completing the main part of the viaduct. The last section of the approach retaining walls was poured Nov. 27, 1915. The fill at the south approach was completed Jan. 20, 1916. The sandstone railing was all in place on Feb. 25, 1916.

The method of setting this railing comprised placing the posts to line and grade on dowels set in the concrete, then fitting the panels to these posts. The parts of the railing were handled by a gantry crane running on steel rails. Blum & Delbridge, Amherst, Ohio, subcontractors for Bates & Rogers Construction Co., furnished and set the railing.

Flood Protection at Columbus

The project for flood protection of the City of Columbus, Ohio, and the Scioto River Valley by means of detaining reservoirs, has been approved in its general features by the Franklin County Conservancy District, and the engineers have been instructed to proceed with the plans. This work and the appraisal will occupy several months, but it is anticipated that the district may be ready to let contracts early in 1917.

Following the disastrous flood of March, 1913, the City of Columbus engaged Alvord & Burdick, consulting



CARRYING WEST 25TH ST. OVER BIG CREEK VALLEY, CLEVELAND, OHIO
was in the foreground of the view

engineers, Chicago, to investigate methods of flood protection. Their report (*Engineering News*, Sept. 25, 1913, and Apr. 2, 1914) recommended improving the Scioto River channel by means of a cutoff passing west of the city, at a cost of $11,263,000, of which the city's share would be $8,500,000. A bond issue for this was defeated.

The engineer's report had pointed out that reservoirs to retard flood waters would aid not only Columbus, but the entire Scioto Valley also. There was at that time no legal form available for coöperation between the city and the other districts affected, but in February, 1914, the Ohio legislature passed an act authorizing the organization of drainage and conservancy districts. Under this law the Franklin County Conservancy District was organized, and Alvord & Burdick were appointed its chief engineers.

The storm that caused the 1913 flood averaged 9.14 in. on the 1,614 sq.mi. of watershed above Columbus, but 2.33 in. of this was stored in two large natural basins. It is estimated that 8½ in. (93%) of this rainfall ran off, but the crest of the flood at Columbus was created by a rainfall on the watershed above of only about 6 in. in two days, half of this falling in the last 12 hr. of that period.

This flood was probably the greatest that has occurred in the valley. Owing to the increasing settlement, however, lesser floods (such as are on record) would be equally disastrous, so that there is increasing menace from smaller floods made dangerous by channel encroachments, levees, etc. In 50 years there have been about a dozen floods that have caused crop damage. The engineers believe that the 1913 flood will be repeated and probably exceeded.

The total loss from the 1913 flood in the Scioto Valley, exclusive of the watershed above Delaware and the tributaries below Columbus, was about $25,000,000. In addition, there were the indeterminate losses due to sickness, unemployment, interruption to traffic and business and the depreciation of property value. For a period of 20 years the flood loss averages about $1,500,000 per year. This sum will tend to increase and to result from the smaller floods as well as the exceptional great floods.

The plan submitted by the engineers and now approved by the district provides for two large detaining basins, or reservoirs, to hold back the flood waters and prevent rapid runoff. One is to be on the Scioto River above Dublin and the other on the Olentangy above Delaware. They will be formed by earth dams. Discharge tunnels in the rock of the hillsides will provide both for flood protection and water storage.

The Dublin dam will have a maximum height of 143 ft. and a base thickness of 980 ft. At the spillway level it will hold 11,148,000,000 cu.ft. of water, flooding 9,580 acres (255,925 acre-ft.). The Delaware dam will be 82 ft. high and 550 ft. thick at its maximum section; it will hold 7,109,000,000 cu.ft. of water, flooding 11,299 acres (163,202 acre-ft.). The dams will be founded on rock and made of unusual thickness.

Ample spillways capacity is provided. To overtop the dams would require a flood over three times as great as that of 1913.

The basins will be supplemented by improving the river channel at Columbus from the mouth of the Olentangy to Greenlawn Ave. This work will include widening and deepening the channel, raising the levees and paving their bends and replacing the destroyed bridges with reinforced-concrete arch structures. The channel will then have a capacity of 50,000 cu.ft. per sec. with a water level 6 ft. below the top of the levees. This is the maximum flood flow that can occur in connection with the detaining basins.

The project as a whole provides for a flood 45% greater than that of 1913. The engineers recommend also the enlargement of the district to include the cities of Delaware and Chillicothe, the flow land included in the basins and the bottom lands benefited along the Scioto and Olentangy Rivers below these basins.

The two detaining basins and the channel improvements will cost $10,125,000. About $2,500,000 of this is for the purchase of land for the basins. But as this area may be cultivated continuously, it will retain its agricultural value, so that it may be sufficient to lease the land or to acquire flowage rights. Water might be held in the Dublin basin to furnish an increased supply to Columbus during the dry period of the later part of the summer. The value of this service is estimated at $1,000,000. Bridge renewals also should not be charged entirely to the district. Deducting the above and other minor assets, the uncompensated cost is about $6,000,000.

Track Elevation and Station at Fort Wayne, Ind.

SYNOPSIS—The Pennsylvania Lines have elevated the tracks through Fort Wayne, on a solid fill between retaining walls, and have built a new passenger station at the street level. The street subways have steel bents and trough decks, the troughs being filled with concrete. The methods of carrying on the work are described.

The Pittsburgh, Fort Wayne & Chicago R.R. (Pennsylvania Lines) has elevated its tracks through Fort Wayne, Ind., and at the same time has built additional tracks and a new passenger station.

This stretch of work has a length of about 1½ mi. It is limited on the west by a double-track girder bridge over the St. Mary's River and on the east by a grade crossing with the Wabash R.R. at Hanna St. Beginning near the bridge there is now a grade rising eastward at 0.487 to 0.312% and covering the greater part of the distance, with a summit at Calhoun St. Beyond this a descending grade of 0.38% for 2,000 ft. comes down to the original elevation at Clay St. and is followed by a rising grade of 0.45% eastward. The maximum elevation above the old grade is about 10½ ft. Fig. 1 shows the new station and elevated tracks, and Fig. 2 is a view of the track elevation through the station.

When this work was undertaken, there were two main tracks—a running track for eastbound freight and an additional track at the station. The daily traffic averaged 18 passenger trains and 17 freight trains in each direction (half of the former being in the daylight hours). In addition there were numerous switching movements and work trains. No yards or railway connections were involved. There are now four tracks all the way from the river and six at the station, the inner ones for passenger traffic and the two outer tracks for freight traffic.

The profile and station layout are shown in Fig. 3. Part of the work is paralleled by the Wabash R.R., which had to elevate its tracks and build subways corresponding to those of the Pennsylvania Lines, as shown.

The new elevated line consists of a sand-fill between concrete retaining walls. These walls are of the gravity type, with vertical face, stepped back and with footings that project both in front and rear (Fig. 4). At one point the restricted width of property made it necessary to eliminate the front footing projection, and consequently the face was battered. The abutments of the bridges at the street crossings are of the same design as the retaining walls first mentioned, as shown in Fig. 5.

There are six street subways. The streets are depressed 6.7 to 9.9 ft., and the tracks are elevated 7.3 to 10.5 ft., the difference in elevation being 16 ft. 8 in. to 17 ft., except that at the two streets having street-car tracks it is increased to 19.8 ft. The sidewalks are not depressed to the roadway level, thus giving easier approaches and a saving in cost of construction.

In building the subways there was very little interference with street traffic, temporary driveways and footwalks being maintained most of the time. However, at certain stages of the work all street-car traffic had to be concentrated at one or other of the two subways having car tracks.

FIG. 1. NEW PASSENGER STATION AND ELEVATED TRACKS OF THE PENNSYLVANIA LINES AT FT. WAYNE, IND.

The bridges over the streets have steel trough-deck spans carried on steel bents and the abutments. Of the six bridges three have four spans, with three intermediate bents. The others have one, two and three spans, the single span being for a pedestrian subway. Fig. 5 shows the typical construction of the three-bent subways.

The bents have steel columns spaced about 13 ft. c. to c. These columns rest on concrete footings, and cross-girders are framed between their tops, with knee-brace connections to the columns. The trough deck is filled and covered with concrete, and the concrete extends over the outer sides of the deck as a fascia girder, both for appearance and to protect the steel.

The concrete deck is finished with ½ in. of neat cement. Upon this is a five-ply waterproofing course of

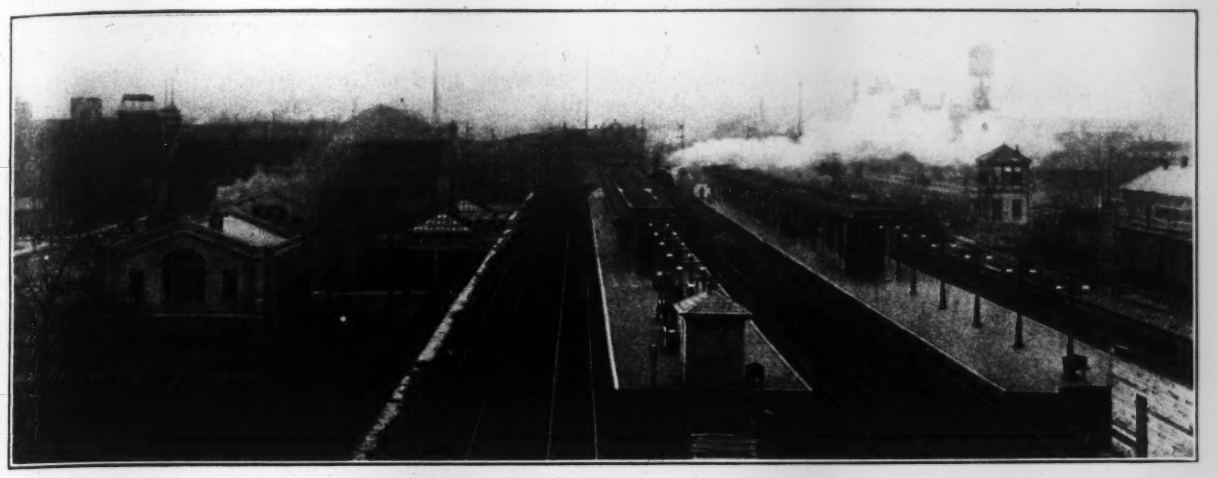


FIG. 2. NEW STATION AND TRACK-ELEVATION WORK AT FORT WAYNE, IND.
The smaller station building at the left is the express building. Between the main building and the retaining wall is a covered concourse

tarred felt and pitch, which extends across the deck and is covered with 2 in. of concrete, upon which the ballast is laid. The top of the concrete slopes down from the center of the bridge to the abutments, to give free drainage.

The columns are of H-section, composed of three web plates and four interior angles. There are four lines of angles on the corners of the side plates, and across these are riveted batten plates for the open sides of the column. The cross-girders have single webs, with flange angles and cover plates. The deck troughs are built up of plates and angles; they vary in width and depth according to the span.

New Passenger Station

The new station is shown in Figs. 1 to 3. It includes the main passenger building and an express building, both at the street level. Between the rear of the passenger station and the wall of the track elevation is a covered concourse, from which a concrete passenger subway 16 ft. wide and 9 ft. 4 in. high extends beneath the tracks. Two sets of stairways lead from the subway to the train platforms, which are 24 ft. wide and 800 ft. long. The platforms are covered for 433 ft. by shelter sheds, which have steam-heated waiting rooms at each end. A subway for baggage, mail and express matter connects with elevators leading to the platforms. It is 10 ft. wide and 12 ft. high and is located directly opposite the station center.

A water main with numerous branches terminating in hydrants on the platforms provides for supplying water to the drinking tanks in the cars. The steam for the waiting rooms on the platform is supplied from the station heating plant through pipes laid in a trench in the passenger subway and up through the wall to the track level, where they branch off. Where the pipes are buried in the ground, they are inclosed in split tile. The wires within the station layout are carried in six-way vitrified-clay conduits laid underground, except where they could be laid in the walls. At the two subways near the station the conduits are laid in the troughs of the bridge deck.

Through the station layout there are four passenger tracks, with a freight track on each side. Provision is made for an additional platform and pair of tracks, or eight tracks in all, as shown in Fig. 3. There are auxiliary tracks also, and crossover connections to allow for various train movements in the station area.

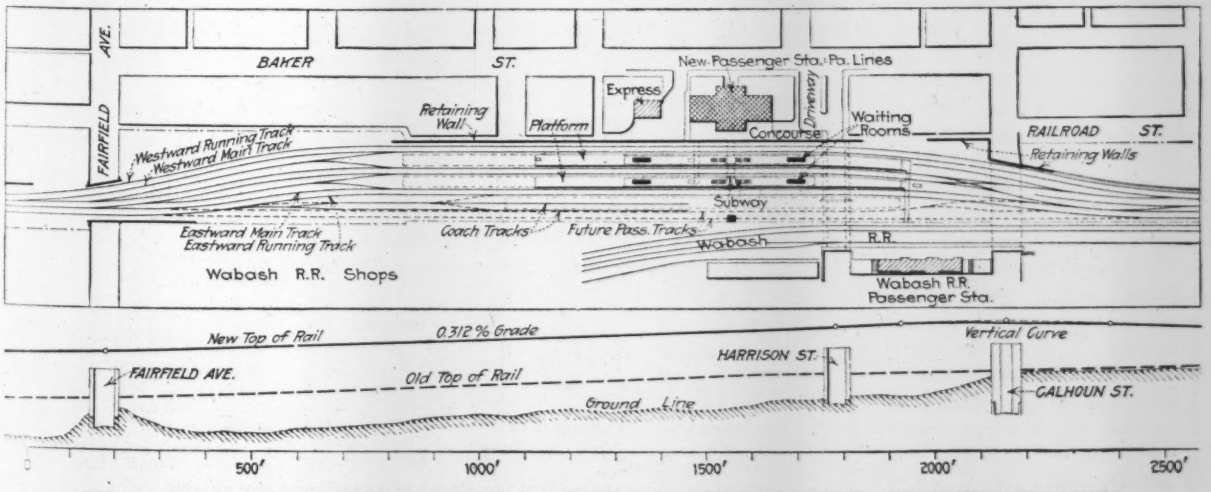


FIG. 3. PLAN AND PROFILE OF STATION LAYOUT AT FORT WAYNE, IND.; PENNSYLVANIA LINES

The construction was done by a combination of contract work and day-labor work. The first step was to lay a new 14-in. water main from the St. Mary's River to supply the tanks at the engine terminal and shops—a distance of about 0.6 mi. This pipe was laid outside the track elevation and took the place of an old 12-in.

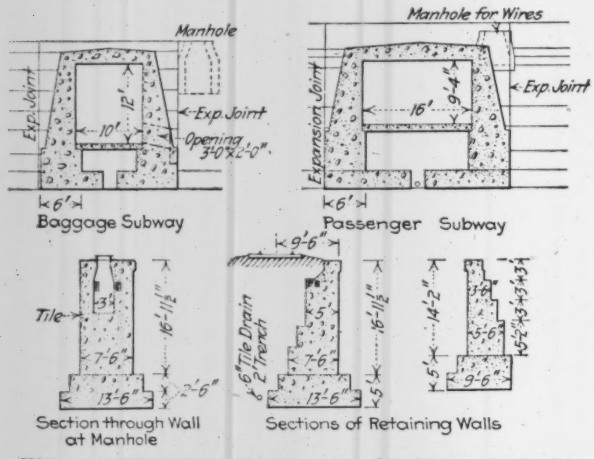


FIG. 4. RETAINING WALLS AND STATION SUBWAYS

main that it was not considered advisable to take up, as its salvage value would have been very small.

The main part of the fill was made with sand from borrow pits at Winona Lake and Grovertown, Ind., 37½ and 74½ mi. distant, only one pit being in use at a time. The grading contractor loaded the cars at the pit with a steam shovel. The railway company furnished the borrow pits and did all trackwork there. It also supplied the trains of gondola cars, spotted the cars at the shovel and hauled the trains to and from the work. Engines and crews were called as needed, the railway company having an inspector at the pit who reported conditions to the office at Fort Wayne.

The tracks were elevated singly and in turn, each track being raised and put in service before the next one was disturbed. In this way, following the method described later, only one track at a time was out of service, and a double-track line was maintained for traffic.

The method employed in elevating a track was as follows: The track to be raised was abandoned and torn up, and an Ohio locomotive crane with a clamshell bucket started unloading sand from cars standing on the adjacent track, these cars being spotted within reach of the crane by the railway company. The track on which the cars were spotted had to be cleared when necessary, in order not to impede traffic. Cribbing of old ties was built as the work progressed, to keep the fill from encroaching upon the adjacent track. While the crane was placing the fill for this track, a piledriver, operated by railway-company forces, was driving piling at the streets where subways were to be built. As soon as the falsework and filling for a track were completed the track was relaid on the higher elevation and placed in service. Work on the next track was then proceeded with as before, and so on until all the tracks had been raised to the proper elevation. Where the fill was so wide that the sand could not be unloaded from existing tracks (as at the passenger station), temporary tracks were built and thrown as required as the filling progressed.

The same method was used for the west end of the work (adjacent to the river), except that limestone screenings were used for filling and were unloaded by hand by company forces. For the extreme east end of the work, sand from Gary, Ind., was used. It was loaded and unloaded by hand, the amount of fill not being sufficient to warrant the use of a steam shovel at the pit or an unloading crane at the fill.

Concreting and Steel Erection

All concreting was done by contract. The ¾-yd. mixer was mounted on a flat-car and discharged the concrete directly into chutes leading to the forms. Behind this were cars containing concrete materials, which were delivered to the mixer in wheelbarrows. The mixer car, with material cars attached, was placed on a track on the trestle at the street where concrete work was being done. This track was put out of service temporarily by a special order and restored to service when no longer needed for the work train.

Each section of abutment had to be completed during the day. The same method was employed in building the retaining walls, except where a temporary track was available.

The erection of the steelwork for the bridge was handled by the railway company's forces and in the following manner: A track was put out of service and the temporary trestle torn down, to permit placing the steel. After it had been placed, the parts were riveted together and the track was placed in service again on stringers laid upon the steel. The steel for another track was then placed, and operations continued as before. Temporary tracks were used from which to place the steel, in case it could not be erected from one of the running tracks on the trestles.

A 50-ton Bucyrus railway wrecking crane was used in placing the steel for some of the bridges. In other instances a 15-ton Ohio locomotive crane or a long-boomed derrick car was used. Part of the riveting was done by hand and part by pneumatic hammers, a shop engine being kept constantly on the work to furnish air.

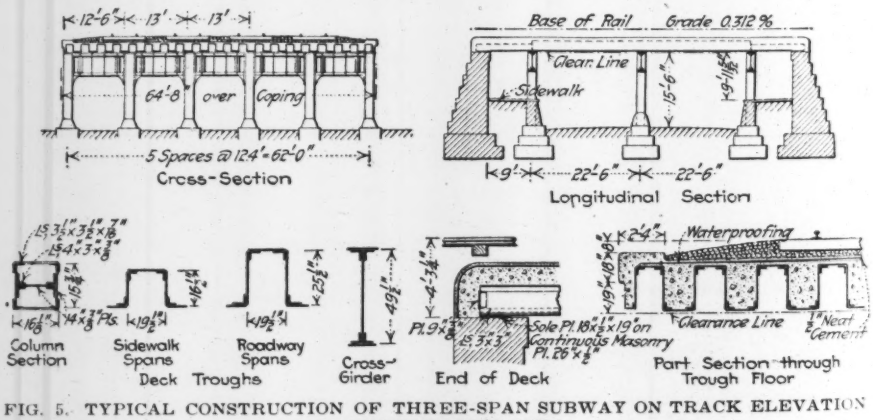


FIG. 5. TYPICAL CONSTRUCTION OF THREE-SPAN SUBWAY ON TRACK ELEVATION AT FORT WAYNE, IND.

The concrete filling was placed in the troughs of the bridges by the contractor, who had the use of tracks for his plant as required. The tracks were given up temporarily and placed in service again as soon as the concrete had hardened sufficiently to carry traffic. Waterproofing was subsequently done under the same conditions as to traffic.

All trackwork was done by company forces. All street work, except placing the concrete curb walls, was done by the City of Fort Wayne. These curb walls were built by the railway company, in order to insure uniform concrete work around the columns.

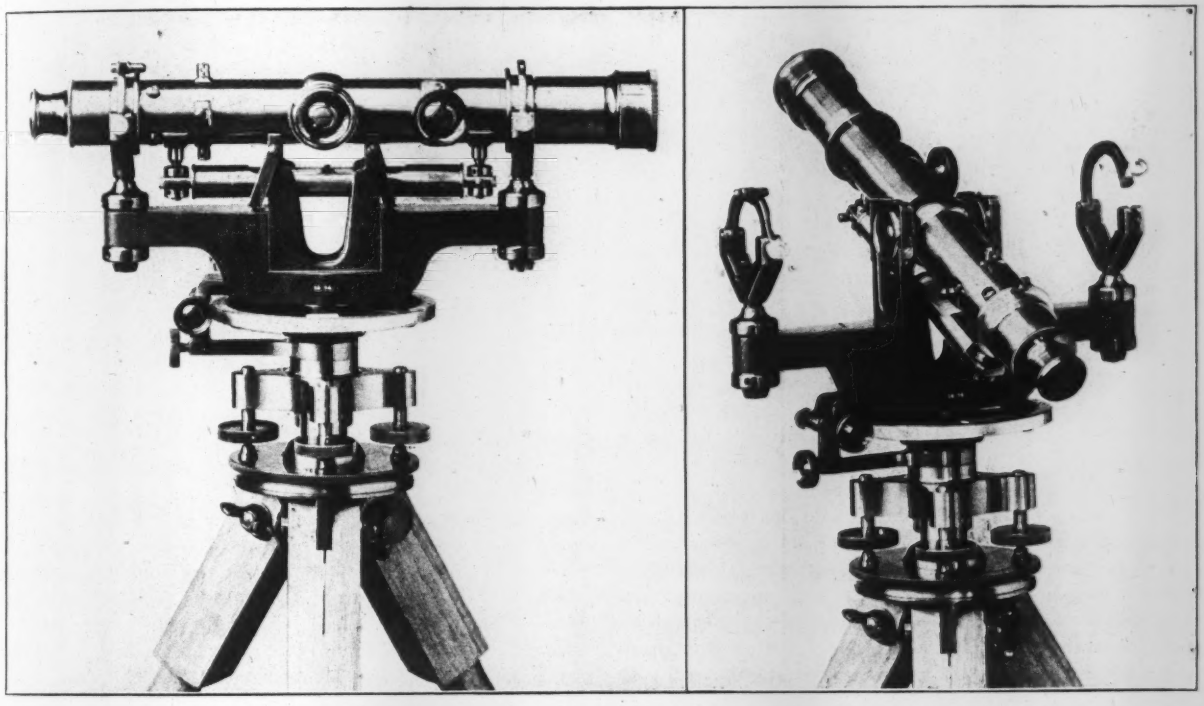
The design and execution of the work were under the direction of Robert Trimble, Chief Engineer of Maintenance-of-Way of the Pennsylvania Lines. The steel superstructure of the bridges was under the direction of J. C. Bland, Engineer of Bridges. The track elevation was in immediate charge of F. M. Graham and Guy F. Scott, who were the Division Engineers at different times during the progress of the work.

The principal contractor was the Herman Tapp Construction Co., of Fort Wayne, Ind., which sublet the grading to the France Co., of Toledo, Ohio. The George B. Swift Co., of Chicago, had the contract for the station buildings, concourse and paved driveways, and also for the platforms with shelter sheds and waiting rooms. The steelwork was divided between the Fort Pitt Bridge Works, Toledo Bridge and Crane Co., Mt. Vernon Bridge Co. and the Riter-Conley Manufacturing Co.

This work was commenced in 1910 and completed during 1915. The cost, including the station site and buildings, was somewhat over $1,000,000. Grade separation is now in progress at the Wayne Trace Crossing, outside the eastern city limits, but it is independent of the work described in this article.

Convertible Level and Transit

A new convertible or tilting Y-level that can be used also as a modified form of transit is shown in the accompanying illustrations. It is intended particularly for the use of contractors and on road or ditch construction work. The view at the left shows the instrument as a level, with the telescope carried in the Y-standards attached to the ends of a drop frame or crossbar. The standards for use with the instrument as a transit have the lower portions cast as part of this crossbar, and the upper portions are hinged to them, being folded down so as to clear the telescope, as shown. To use the instrument as a transit, the telescope is removed from its position in the Y's (parallel to the bar), and is placed crosswise to the bar in the standards, the upper parts of which are raised for the purpose. It is termed a modified transit for the reason that the telescope cannot be turned through an entire circle, but the drop frame admits of movement through an angle of 90°, from 45° above to 45° below the horizontal line. The conversion can be made in a few seconds. A special feature is that there are no detachable parts to be lost or mislaid. The transit standards form a permanent part of the instrument, the upper portions being hinged so that they can be folded out of the way when not in use. This instrument is manufactured by the David White Co., 419 East Water St., Milwaukee, Wis.



A NEW CONVERTIBLE LEVEL AND TRANSIT FOR USE ON CONSTRUCTION WORK
The instrument is shown at the left as a level and at the right as a transit

Steam Power Plant with 96.4% Load Factor—Four steam-engine driven generators in the Perth Amboy, N. J., works of the Raritan Copper Works operate usually for over 95% of the total time. In the five months from August to December these engines (four-cylinder triple-expansion 21-, 38-, 44- and 44x48-in. Nordberg-Corliss engines driving 900-kw generators) averaged 96.4% of total possible time in service. The lost time was consumed in adjusting valve gears, etc.

Pneumatic Concrete Mixing and Placing, New York Subway*

By A. E. Comstock†

On Section 5 of the Broadway-Fourth Ave. subway, which includes the two-track structure on 59th and 60th St. from Seventh Ave. east to Second Ave., the concrete lining of the tunnels and other structural concrete are both being placed by compressed air. The machine used for this purpose is designed for both mixing and placing concrete.

It consists of a drum about 4 ft. in diameter by 2 ft. deep, on the under side of which is attached an inverted cone-shaped section extending about 3 ft. below the bottom of the drum and terminating in a 6-in. discharge pipe. On top of the drum is a feeding hopper, and inside is a horizontal door, sliding in cams so adjusted that, in closing, it is brought tightly against a gasket on the top of the drum, thus making an air-tight lock. The door is operated by a hand lever connected to it by a piston rod passing through the drum.

The cone-shaped section underneath the drum is fitted near its top and bottom with about 12 small inlet pipes, through which air is forced for the purpose of agitating the materials until they are thoroughly mixed before the mixture is driven through the discharge pipe to the forms. The discharge pipe is attached to the cone by a T-connection, from the free end of which a 2-in. pipe leads to the compressed-air reservoir, and another 2-in. air connection is located at the top of the drum.

When the process of mixing has been completed, the air is turned on at both connections, the air through the upper one forcing the concrete down into the discharge pipe, while the air through the lower one forces the concrete forward to the forms.

When the machine was first put into operation on this contract, the agitators were not used, as it was thought that the materials would become sufficiently mixed in transit through the discharge pipe and upon being deposited in the forms. Repeated trials made by this method proved unsuccessful. The aggregates failed to mix properly with the cement and water and were deposited in the forms in a condition varying from very wet to dry. Being deposited under an initial pressure close to 100 lb., the materials that had become only slightly wet were compacted to such an extent that rehandling was difficult and involved considerable loss of time. Furthermore, an appreciable amount of sand and cement that had not come in contact with the water was blown clear of the forms. Later developments showed that dry materials had a tendency to clog the pipe more frequently than those thoroughly mixed with water.

Various methods and contrivances were used to overcome these difficulties and obtain a better mix, but without satisfactory results. An attempt was then made to use the agitators, but these were found to have become obstructed with cement to such an extent that it would have required a considerable loss of time to clear them. Moreover, it was the opinion of the engineers that the agitators would fail to do the work for which they were designed; for when the materials are placed in the mixer, they drop first into the discharge pipe and fill upward from that point, and all materials below the lower set of agitators would not be affected by them. Also, the agitators would act simply as an air inlet and would immediately cause the discharge of the materials from the machine before mixing could take place.

An arrangement was then made by which the materials could be thoroughly mixed to the proper consistency before being placed in the air mixer. This method, with proper spading and sufficient rehandling in the forms when necessary to insure an even distribution of materials, has resulted satisfactorily and is the method now being used. The arrangement of the plant at the mixing point was such that with a slight modification this method of mixing could be used continuously.

Two storage bins, one for sand and one for gravel, each with a capacity of about 12 cu.yd., are erected with their tops at the level of the street, in such a position that trucks discharge into them conveniently. At the bottom of each bin is a gate through which the materials are run into a hopper gaged for measuring the sand and gravel. At this point there is a platform, covered and waterproofed, where the cement is handled and temporarily stored, on which is located a water tank fitted with an improvised measuring gage and connected to a steam boiler for the purpose of heating in cold weather. The steam pipes also pass through the storage bins for the same purpose. At the bottom of the measuring hopper is one gate which, when opened, allows the sand and gravel, to which the cement has been added, to run together into the mixer.

Before experimenting with the air mixer, a rotating mixer had been in use in placing the track floor and wall benches. Space was provided in the arrangement of the plant to set aside one mixer in case it was desired to use another. Upon the failure of the air machine to mix properly, it was replaced by the rotating machine, lowered to a position above the air machine and so arranged that the rotating machine could thoroughly mix the materials and discharge into the latter with the previously mentioned satisfactory results.

Points To Consider in Using Air Conveying

The discharge pipe should be laid in the most direct line between the mixing point and the forms, avoiding bends as much as possible, since all bends retard the passage of concrete through the pipe, encourage congestion and increase the time of transit as well as the consumption of compressed air. Where bends are necessary, they should be sweeps of large radii, about 15 or 20 ft. Short bends of 4 or 5 ft. were used on this contract in the early experiments with this method and were found to clog more frequently than those of larger radii and to wear through in a few hours, with consequent loss of time for repairs.

When the pipe becomes clogged, sounding at the point of congestion will usually loosen the obstruction; but it is sometimes necessary to remove the obstructed part and clear it by other means. At every point where the pipe changes direction there is a decided shock when the concrete strikes the bend. It is therefore necessary to have such points securely braced, in order to prevent un-

*Extract from paper by Robert Ridgway, Engineer of Subway Construction, Public Service Commission, New York City, entitled "Some Features of Concrete Work on Subway Construction," New York City, and read before the American Concrete Institute, at Chicago, Feb. 14, 1916. This particular part of the paper was prepared by Mr. Comstock.

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necessary strain on the joints, particularly at the outlet, where the shock would otherwise cause a shaking and consequent loosening and displacement of the forms, if there is any contact between the pipe and the forms—a condition that cannot always be avoided. The original position of the outlet of the discharge pipe should be located centrally in the forms, since each change of pipe means additional loss of time for bracing.

In passing through the discharge pipe, especially over long distances, the concrete has a tendency to spread out along the bottom rather than move in a solid mass through the full section of the pipe. If this condition continued to the outlet of the pipe, much of the air would pass over the materials, resulting in a loss of pressure, a longer

VIEW IN 59TH ST. SUBWAY, MANHATTAN, SHOWING PIPES FOR PNEUMATIC CONVEYING OF CONCRETE

All concrete shown here was mixed in a rotary batch mixer and was transported to the forms by the pneumatic method

time in discharging and a separation of materials at the outlet. In order to avoid this it is necessary to have a rise, vertical or nearly so, at or near the point of discharge, so as to cause the concrete to fill the pipe completely and to discharge more uniformly.

In order to obtain the proper distribution of concrete in the forms with as little rehandling as possible, a flexible rubber pipe was attached at the outlet, with the idea of directing the flow to different points, as desired. This proved practically useless, as the pipe buckled, was difficult to control and was soon worn out. It was therefore replaced by a T-connection that could be turned to any desired angle in a vertical plane and satisfactorily provided the required distribution.

This method of placing concrete is particularly adapted to filling tunnel arches, the discharge pipe being laid along the crown of the arch to about the middle point of length of the section and the T turned alternately on each side until the arch is filled to the level of the crown. The T is then removed and replaced by a piece of straight pipe extending to within a few feet of the far end of the form, the whole length of pipe inside the form is raised to a position tight against the rock along the highest available line, and concrete is pumped in until the arch is filled up to the outlet of the pipe. The pipe is then removed and replaced by a shorter piece extending about 6 in. into the form at the most advantageous high point; the bulkhead is sealed and the blowing of concrete resumed until the arch is filled to the point of refusal. The pipe is left in place until the concrete has set long enough to be firm, when it is removed and cleared of any concrete remaining in it. It is impossible to seal completely all voids in the roof of a tunnel by this method of placing concrete, unless the rock breaks fairly smooth without leaving pockets above the general surface.

Care must be taken to avoid overtaxing the forms, as the high pressure of air added to the weight of the concrete is likely to displace or rupture them, and such an accident actually occurred at one point on this work. On this contract the point of deposit farthest from the mixer is about 500 ft., and the time required to discharge a two-bag batch of concrete over this distance varies from 30 to 40 sec. Each batch is mixed for about 1 min., during part of which time the previous batch is discharged into the forms. Under favorable conditions about 1½ min. are required to mix and place each batch; but on account of time lost in spading the mix in the forms, occasionally changing the position of the pipe, clearing obstructions and waiting for the proper amount of initial air pressure, a fair average between batches may be assumed as about 3 min. The time required decreases in length as the point of deposit approaches nearer to the mixer. It therefore requires about 12 hr. to line a section of tunnel roof 25 ft. long, which contains 80 cu.yd. of concrete, including excess.

At the present time there are two single tunnels and a double tunnel, each about 300 ft. in length, being constructed by this process. Part of this double tunnel is open-cut construction, where complete tunnel sections above the track floor, each 10 ft. long, are being poured at one time as monoliths. The work is in progress at three points, thus keeping the machine in practically constant use. Steel forms and carriers are being used for tunnel sidewalls and timber arch forms on steel carriers for the tunnel roof.

The Busiest Street Intersection in the world is in New York City at Fifth Ave. and 42nd St., according to a recent count by the Traffic Committee of the Fifth Avenue Association. According to this investigation, between 3:30 and 4:30 p.m. on the day of the test, 1,149 vehicles were counted proceeding south. J. Bernstein, who made the count for the committee, stated that the top figure for the Strand, London, is 900 vehicles per hour, and in Paris the record is 600 in an hour on the Boulevard des Capucines. The count revealed other interesting statistics: Of the vehicles on Fifth Ave. at 42nd St. 92% are now motor driven. Between 8:30 a.m. and 6:30 p.m., under unfavorable weather conditions, 7,762 passenger vehicles were counted northbound, of which 300 were commercial (of these 60% were horse drawn), while 600 busses passed in the 10 hr. The grand total was 8,862. The traffic peak was between 2:30 and 3:30 p.m. Southbound in the avenue the total for the day was 7,190, consisting of 6,388 passenger vehicles, 198 commercial and 604 busses. On 42nd St. the total from east to west was 4,716; and from west to east, 3,909.

Railway Ditching Trains

The work of cleaning roadway ditches and widening cuts is now being done on a number of railways by means of a short ditching train having two air-operated dump-cars and a power ditcher instead of by a long train of flat-cars with ditcher and unloader plow.

The smaller train of dump-cars can be unloaded at almost any point for filling bridges, widening banks or wasting the spoil, so that the length of haul from the cut to the dumping point is usually only from 1 to 4 mi. As the train can be handled rapidly and requires only a short length of sidetrack to hold it, it can easily be kept out of the way of regular trains, thus minimizing the interference with traffic without losing time for its own work.

The cars are operated by air and controlled from the locomotive. As they throw the load clear of the ballast, they can be dumped while the train is moving. Another important point is that such a train can be handled readily by a light locomotive. The crew will consist of about 8 men.

The complete train consists of a locomotive, two 20-yd. dump-cars, a ditcher, a spreader-car and a caboose. Sometimes there is a water-tank car in addition. The ditching machine, built by the American Hoist and Derrick Co., of St. Paul, Minn., is a small revolving steam shovel with ½-yd. bucket. It is mounted on a portable track on a flat-car placed between the two dump-cars, so that it can load them both. It is so connected that, while the train is running, the machine can pump water from the tender or tank-car to its tanks, thus saving time otherwise lost in taking water. The two cars can be loaded in about 30 min.

On one road, with an average haul of 1 to 4 mi., the train makes 10 to 20 trips per day. In that time it handles more material than a work-train of 15 flat-cars (10 cu.yd. per car) with ditcher and unloader plow. The latter train requires a crew of about 12 men and loses time in shifting the ditcher, plow and plow cable at each trip. With such a train the ditcher travels along it, loading each car in turn as it comes to it.

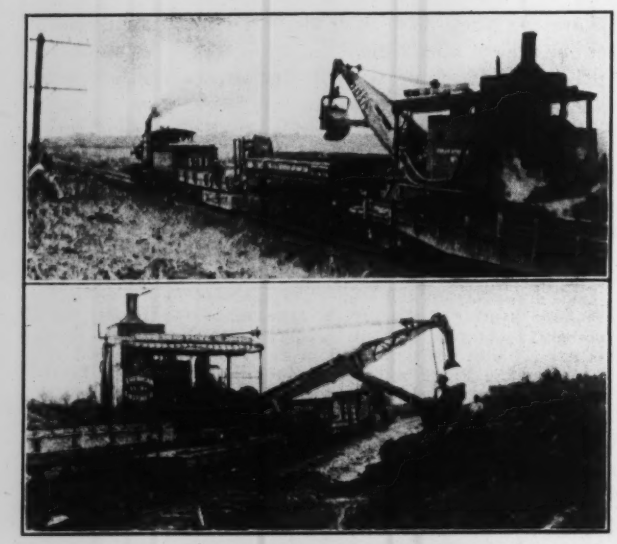


FIG. 1. DITCHING TRAIN WITH POWER DITCHER SERVING TWO DUMP-CARS

The diagram, Fig. 2, has been prepared by the builders of the ditching machine for estimating the amount and cost of work to be done in this way with a train having one ditcher and two 20-yd. dump-cars. The diagram is for ditches 2 to 3 ft. deep. The excavating capacity is

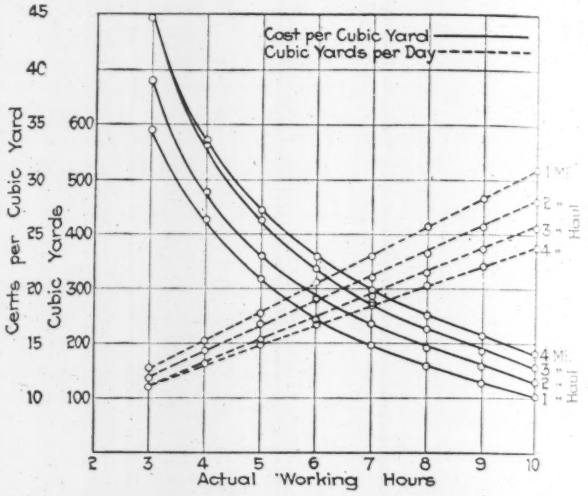


FIG. 2. COST AND PERFORMANCE OF WORK TRAIN WITH POWER DITCHER AND DUMP-CARS

60 yd. per hr.; speed of train, 20 m.p.h.; distance to switch or dump, 2 mi. The daily cost of work train (wages, fuel, oil, interest and depreciation) is taken at $53.76. For a ditch 2 ft. deep and 6 hr. productive time per day the work will amount to 280 cu.yd. at about 20c. per yd. Where there is much ditching to be done, the train may have four dump-cars and two ditchers (each ditcher between two cars).

Tunneling for Water in Oahu

By Kenneth Q. Volk*

The Oahu sugar plantation is situated on the Island of Oahu, in the Hawaiian group, upon which is the City of Honolulu. In 1911 the company owning this plantation was pumping about 80,000,000 gal. of water daily for the irrigation of cane, operating the pumps against average lifts of 420 ft. and running them 300 days out of the year. California oil was used for fuel.

The amount of water put on the land is surprisingly great. M. M. O'Shaughnessy estimated that in 1909 there was 250,000,000 to 300,000,000 gal. of water being pumped daily by various plantations on this island for the irrigation of cane. The island is divided by a mountain crest on the windward, or northern, side. The precipitation ranges from 40 in. at sea level to 100 in. on the divide, with rainfalls of but 15 to 20 in. on the lee side of the island, where are situated most of the cultivated lands. The drainage basins on the windward exposure of the island are short and precipitous.

In order to avoid the heavy pumping costs the Oahu plantation decided to drive a series of collecting tunnels on the windward side of the island to pick up a number of streams, which were to be brought under the main range of mountains in a long tunnel to the southern slope, at an El. 750 ft. above sea, from which point the

*Engineering offices of J. B. Lippincott, Central Building, Los Angeles, Calif.

water would be distributed over the plantation. This enterprise was reported upon for the company by a number of engineers at different times, including M. M. O'Shaughnessy, James D. Schuyler and J. B. Lippincott. Mr. Lippincott laid out the general plan for the work in 1911. The main tunnel lengths are as follows:

	Ft.
Kahana collection tunnels.....	8,677.9
Waikane collection tunnels.....	15,943.1
Main tunnel through the crest...	14,567.0
South-side tunnels	19,211.6
Total	58,399.6

There are also several miles of canals and siphons on the southern side of the island.

Jorgen Jorgensen is the contracting engineer. Charles H. Kluegel and James M. Young have been the engineers representing the company during the construction. On Dec. 22, 1915, the main tunnel was holed through, and the work has been successfully accomplished.

The rock through which the excavation has been driven is volcanic, and the distinct feature of the work was the enormous volume of water encountered. When the operations were well under way on the northern, or upper, end of the tunnel, flows of 30,000,000 gal. daily were encountered, while on the southern, or lower, end from 10,000,000 to 15,000,000 gal. occurred. The main tunnel is not now producing as great a flow as this, but it is delivering a very substantial volume.

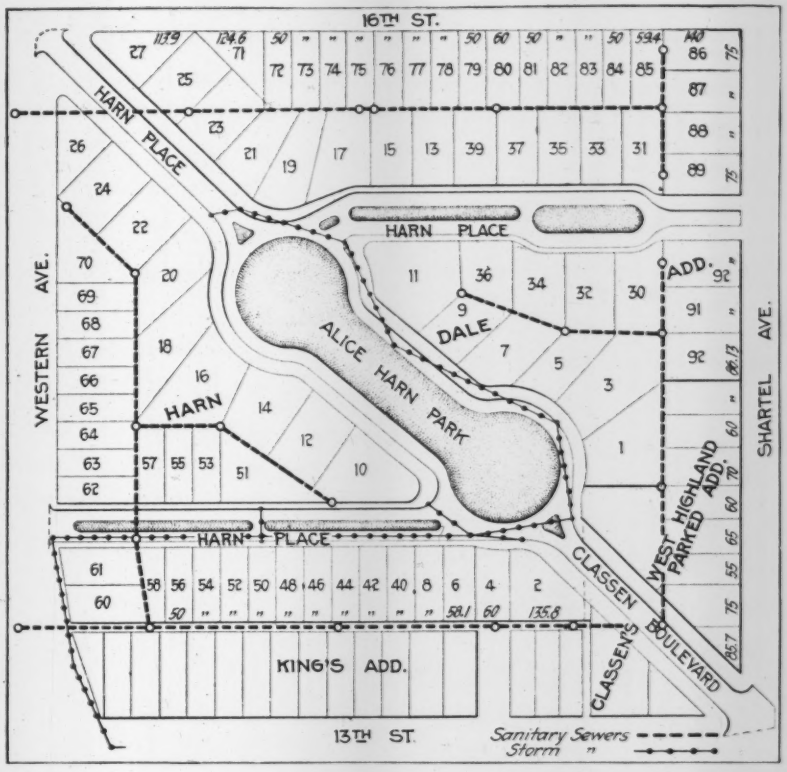
The work was done for the Oahu plantation by the Waiahole Water Co., of which George Rodick, of Honolulu, is president.

This account is written merely to chronicle the completion of an important engineering undertaking. It is to be hoped that some of the engineers in intimate charge of the work during its construction may give the profession the benefit of some of their experiences in much greater detail than is contained herein.

Some Crazy City Planning

Just to illustrate how crazy a city plan can be made and just to give an idea of some of the intricate engineering problems such a crazy city plan gives rise to, the accompanying sketch is shown. It illustrates a recent addition to the street system of Oklahoma City, practically forced upon the city against the remonstrance of its engineers by an eccentric lawyer. In dedicating certain plots to the city as public parks the grantor has obligated the city to call every street within the layout "Harn Place," with the additional odd obligation that the houses are to be numbered as the lots now are! A study of the plan will prove interesting.

The lots and streets were originally laid out when most of the land was in plowed fields. Wooden hubs were used for corners and a large part of them have been plowed out. It was recently necessary to draw plans and specifications for the sewering and paving of this district. Since it would be practically impossible to give in words a conception of the difficulties involved in this work, a great deal has to be left to the imagination of the reader and to an inspection of the plan.



LAYOUT OF PAVEMENTS AND SANITARY AND STORM SEWERS OF A RECENT ADDITION TO OKLAHOMA CITY

To determine the amount of paving and grading, it was first necessary to establish the street and curb lines. With many of the original hubs gone, the difficulties of this work can be more easily imagined by the experienced surveyor than described here. Had it not been that the hubs at the centers of the two circular park plots were found, the task would probably have been impossible.

The design of sanitary sewers was complicated by the practically inviolable custom which requires that they be placed in alleys in the rear of the lots. As these lots had no rear alleys, it was necessary to locate the sewers on the division lines between the rows of lots. This procedure, it will be seen, necessitated accurately establishing all the rear corners of the lots, just as the survey for the pavement required the front corners to be located. Assistant City Engineer Hart spent many weeks reproducing these lot lines before plans could be drawn.

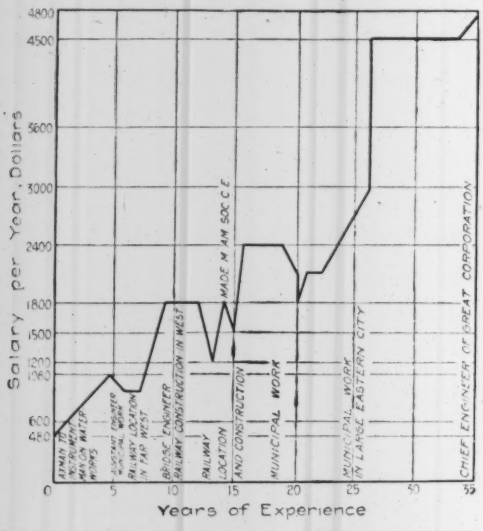
The design of the storm sewers required considerable ingenuity to care for surface drainage on an area with elevations varying by differences up to 30 ft. These sewers and catch basins are as shown in the street areas. There is a hump in the middle of Alice Harn Park, so that the surface water of the east boulevard drains both ways into catch basins on the curves.

This layout makes it obvious that if a real-estate owner, even though he be a lawyer, wishes to dictate in city-planning matters, he had better consult someone versed in the art, or at the least someone conversant with the elements of municipal engineering, before he formulates his dicta.

Thirty-Three Years of the Life of a Successful Engineer

The ups and downs of a civil engineer's life—and not an average engineer either, but one who was unusually successful—are admirably illustrated by the accompanying chart. The end of the chart, when the man became chief engineer of a great corporation, is not shown, but is left to the imagination; the chart is concerned only with the various steps by which he achieved this distinctive berth.

The 10 yr. in western railway construction is typical of the experience of a great many of the more elderly



EXPERIENCE CHART OF A CIVIL ENGINEER

engineers of today, only this one was more than usually successful in being continuously employed.

This man was not a technical graduate. Probably the majority of his contemporaries were not. Nevertheless the chart will bear study by young technical graduates and prospective graduates. Salaries and conditions have not changed essentially in the lower grades of the profession, and bearing in mind that this man could be considered a most successful engineer, in all worldly senses at least, a study of the chart ought to help dispel any great anticipations of large financial reward.

Repair of Break Around Seneca Falls Dam

In *Engineering News*, Sept. 16, 1915, p. 571, there was described the development of a break around the end of dam No. 2 on the Cayuga and Seneca Canal, near the town of Seneca Falls, N. Y. The conditions surrounding the break were unusual; and the work of repair, which has just been completed, was interesting.

It will be recalled that here are placed two locks of the New York State Barge Canal, each having a lift of 21½ ft. A 4-mi. level is maintained by a dam 475 ft. long, made up of an earth-fill section on the south end, a pair of twin locks in the center and a solid concrete section at the north end. The break occurred at the north end and was caused by the development of a semi-circular channel around and beyond the cutoff wall, which was carried 50 ft. into a bank of shale rock. It was found that the blowout tunnel was from 6 to 15 ft. in diameter and 120 ft. long. No damage was done other than caving of the bank at the outlet, where 10,000 cu.yd. washed out into the river below.

The repair consisted of cutting out the soft rock in the blowout tunnel and filling with concrete. Also, it was determined to carry the cutoff wall about 100 ft. farther into the hill. A deep trench was excavated on the surface to an elevation 8 ft. below the top of the dam, where a medium-hard limestone was encountered, except for a couple of broad cracks that went down from 15 to 18 ft. and also just beyond the end of the old cutoff wall, where the rock was poor all the way down to the blowout tunnel. After the tunnel had been driven a short distance a fault in the rock was disclosed, the line crossing the tunnel at a small angle. This fault explains the loose rock and probably was the cause of the blowout.

As shown in Fig. 4, in excavating below the blowout tunnel one short and one extended stratum of soft rock were encountered. The little one, hardly more than a finger, was excavated and entirely filled with concrete. A course for the core-wall extension was tunneled into the hillside through the soft material. To remove the poor rock and for convenience in placing concrete, a shaft was sunk at the end of the old cutoff wall. Five-inch drill holes were put down, as shown in Fig. 4, and the tunnel was

FIGS. 1 AND 2. ENTRANCE AND OUTLET OF BLOWOUT TUNNEL AT SENECA FALLS

FIG. 3. CAYUGA AND SENECA DAM NO. 2, AFTER REPAIRING BREAK OF SEPT. 3, 1915

filled with concrete from above through them. Bulkheads were built across the tunnel to enable concreting in sections. The shaft was concreted up to the level of the dam. For the tunnel, shaft and adjacent part of the blowout, a 1:2½:5 mix was used. The vent of the blowout was filled with 1:4:8. A retaining wall was

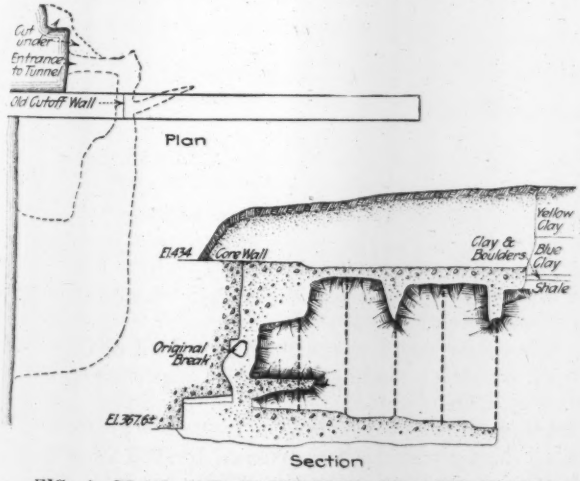


FIG. 4. PLAN AND ELEVATION OF CORE-WALL EXTENSION

placed where the outlet of the blowout tunnel had been and where the bank had caved. For 14 ft. the backfill was finished level with the top of the wall and then sloped up 1 on 1½. Some 3,000 cu.yd. of concrete was used in making the repairs around the dam.

Opportunity has been taken in connection with repairing the break to construct a concrete scouring apron and pave the spillway channel immediately beyond this apron with riprap, although this work is not in any way concerned with the repair of the break. The work was all completed and the reservoir filled Feb. 12, 1916.

Compression Test for Bronze; New York Central R.R.

In its specifications for phosphor bronze and other bearing metals required in movable bridges, turntables, etc., the New York Central R.R. (Lines West) is using a compression test. Compressive strength and the ability to stand a certain specified load without cracking are the most important requirements. A Brinell hardness test is also required, and minimum and maximum hardness members are fixed for certain metals. Little is specified concerning the chemical composition. The specification is as follows:

METALS FOR LININGS

Linings shall be made of alloys as specified herein. The linings shall be fine grained and of uniform structure throughout, free from gas cavities, oxidized metal and any segregation of metal. In making the alloys the best foundry practice shall be pursued. It is recognized that the requisite qualities are not alone shown by the chemical composition and physical properties. A chemical test and a physical test of each heat shall be furnished.

Test Coupon—The coupon for physical-test specimen shall be poured and treated in a way so that it will be truly representative of the casting.

Compression Specimen—The compression-test specimen shall be a finished cylinder 1 in. high and of 1-sq.in. cross-sectional area. This cylinder shall bear a 100,000-lb. load

without cracking. The elastic limit is the load which gives a permanent set of 0.001 in.

Hardness Test—Metal for linings shall be tested for hardness by the Brinell method. The ball shall be of hardened steel, 10 mm. in diameter. A load of 500 kg. shall be applied for 30 sec. to a finished plane surface of the casting or the untested specimen. See "Transactions" of the American Institute of Metals, Vol. 8, pp. 152 to 157.

At least two tests shall be made of each heat. In trunnion linings a test shall be made for each bearing. A record of tests shall be furnished.

Phosphor Bronze—Phosphor bronze shall be used for high pressure and slow speed.

Phosphor bronze shall be a copper-tin alloy, phosphorus not to exceed 1%. Other ingredients not above one-half of 1% will be allowed, except that no sulphur will be allowed. The phosphorus shall be introduced in the form of phosphor-tin alloy.

Phosphor shall have the following physical qualities, as determined on the cylindrical specimen under compression:

For sliding on soft steel: Elastic limit in pounds per square inch, 19,000 to 23,000; permanent set in inches under 100,000 lb., 0.12 to 0.20. For sliding on hardened steel: Elastic limit in pounds per square inch, 25,000 to 32,000; permanent set in inches under 100,000 lb., 0.07 to 0.10.

A hardness test shall be made.

Bronze for Bearings—Bronze for machinery bearings shall be a copper-tin alloy, with tin from 10 to 12%. Sulphur will not be allowed. Zinc up to 2% may be used. Other ingredients up to one-half of 1% will be allowed. Bronze for bearings shall have a hardness not less than 60 nor greater than 70.

Bronze for Wheels—Bronze for nuts and toothed wheels shall have about the same chemical composition as for bearings. It shall have the following physical qualities: Minimum ultimate tensile strength, 32,000 lb. per sq.in.; ultimate elongation in 2 in., minimum 0.10%, maximum 16%.

The bronze shall be tough and free from brittleness.

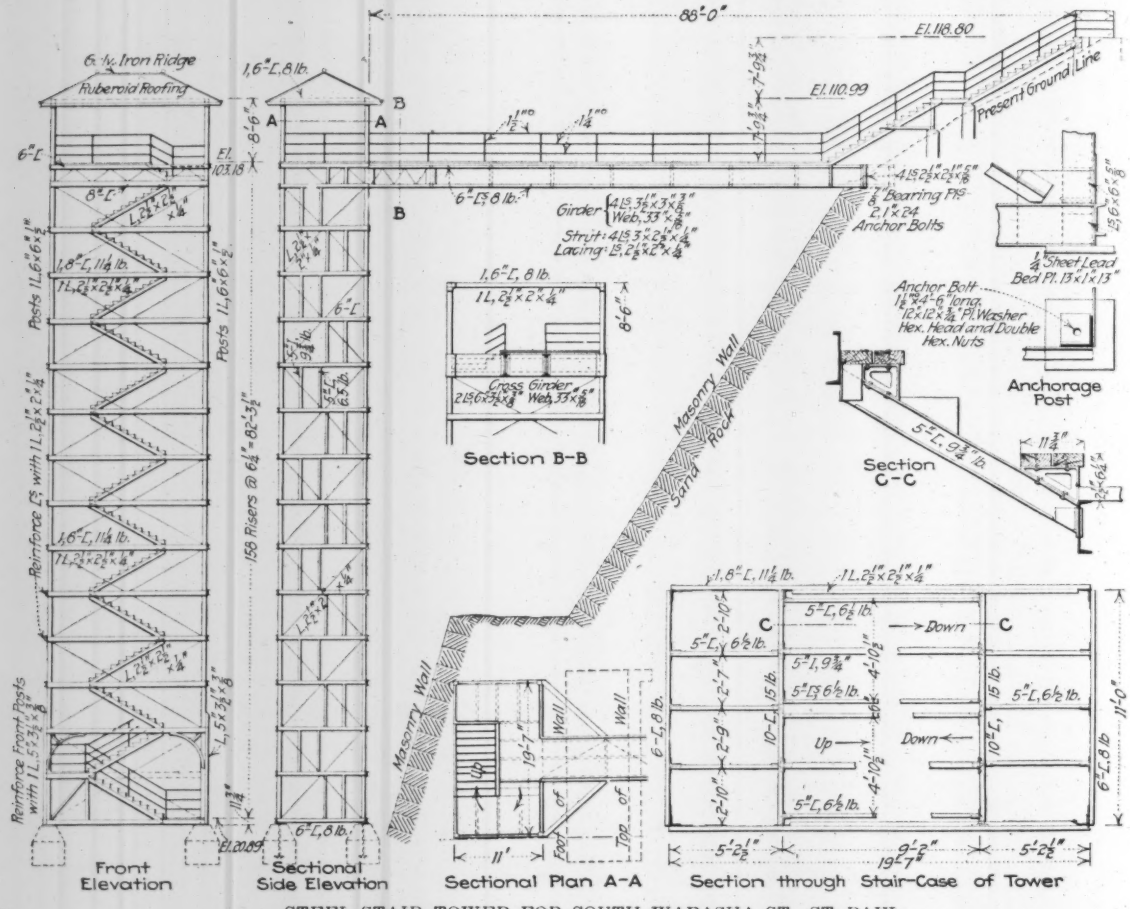
Babbitt Metal shall be a copper-tin-antimony alloy. Its hardness shall not be less than 25 nor greater than 32.

Steel Stair Tower for Bluff

The City of St. Paul is about to build a steel stair tower on the line of Hall Ave. to connect South Wabasha St. and Prospect Terrace across the gap made by the Mississippi River bluff. Most of the bluff is of the soft St. Peter sandstone.

The structure (see drawing) is exceedingly simple, consisting of four posts, channel girts and single-angle diagonal bracing. The posts are single 6x6x½-in. angles. The stairs are in reverse flights connected by landings whose beams support the stair stringers.

The tower is open in its full height, and the stairs are provided with railings on both edges. At the top a plate-girder bridge of 60-ft. span connects the tower with a point near the top of the bluff, whence a stairway of two flights leads to the top.



STEEL STAIR TOWER FOR SOUTH WABASHA ST., ST. PAUL

The tower frame is designed for a load of 50 lb. per sq.ft. on stairs, landings, etc. The platforms and stair stringers are designed for 100 lb. per sq.ft. The top landing, which by means of a transverse girder carries the bridge girders, is proportioned for 150 lb. per sq.ft. The wind pressure is taken at 30 lb. per sq.ft.

There is 10,000 ft. B.M. lumber in the structure and the weight of metal is 53,000 lb. The contract has been let to the St. Paul Foundry Co. for $3,900.

The structure was designed by M. S. Grytbak, bridge engineer, under O. Claussen, Chief Engineer, Department of Public Works, St. Paul.

Origin of the Southern Pacific Taper-Curve System

By William Hood*

In *Engineering News* of Sept. 16, 1915, there was published a review of a book on "The Railroad Taper," by Lee Perkins; and the reviewer raised the question why the 30-ft. chord length was originally adopted in the system of spiral curves developed by the writer, instead of some even fraction of 100 ft.

In answer to this question I would say that the transition, or spiral, curve of the form which I devised and tabulated in the spring of 1881 had a basic chord length of 30 ft.; and I applied to it at that time the word "taper," because it was one word and a short word and approximately descriptive of the compound curve.

The reasons for the selection of a 30-ft. chord length instead of using a quarter, a half, a third or other even fractions of 100 ft. were that the rails we were using were mostly 30 ft. long, with short rails between 26 and 30 ft. In curving rails in advance of track laying, with a 30-ft. chord length, a point on a curved rail need never be located more than 15 ft. from its theoretically perfect position. For convenience of measuring deflection, tenths of 100 ft.—for instance, three-tenths of 100 ft.—give in general more readily handled total curvature and deflections than a quarter or a third of 100 ft.

Probably any form of transition curve is good enough after a road is once constructed, if it is correctly maintained in the track. An important consideration in the selection of these curves, however, is facility and economy of field and office work in construction. Avoiding field computations of a character to delay the work of an expensive locating party or of construction is important. A locating party, with its field office and with its expensive water- and supply-hauling outfit, will often cost $100 a day in a desert mountain country. Lost time in a field computation therefore must be applied to the entire daily cost of the organization. For these reasons the form of taper tabulations mentioned, with the tables pasted into the front and back of the transit books, was found to give the best economy.

The tapers, changing as follows, will be found to meet practically all conditions for new railroad construction: Changing rate of curve with each 30 ft.—15′, 30′, 60′, 150′. For relocating track originally laid with plain curves, to introduce tapers, a greater variety is expedient to obtain economy in minimum track shifting.

Concerning the relation of the speed of the train to the length and number of the taper curve selected, it may be said that it is always best to select the longest and flattest taper that is financially practicable, regardless of the speed of the train. If the most desirable taper will cost too much money, then get along with a less desirable taper, bearing in mind that railroad trains of high speed are operated on lines laid without any taper curves and particularly bearing in mind that, when a train or any part of a train is once on the main curve, the taper has no more effect; and further, that it is no more appropriate to run beyond a proper speed on a tapered main-line curve than to run at the same speed on a curve of the same degree that is not tapered.

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I presented a paper before the International Engineering Congress last fall, entitled "The Locating of a New Railway Line," and the following extracts give some further suggestions relative to the economical use of tapered curves:

The usefulness of the taper depends on the general maximum running speed of the trains in the several localities; and where speed restrictions result in slow speeds, as for instance either up or down steep mountain grades, the taper is not needed to a very great extent. In such localities a very short taper is justifiable, if it will save cost of construction as compared with a longer taper.

On valley lines a taper beginning with 30 ft. of a 15′ curve leaves nothing to be desired for the use of the fastest trains. On mountain side and similar lines with steep grades and moderate grades a taper beginning with a 2° 30′ curve is found excellent in its results and is justifiably used where a flatter (and longer) taper would involve increased cost of construction.

Too flat a taper and too long a reversing tangent increase cost of construction in a mountain country with steep transverse slopes or in a confined river gorge where flood water is dangerous and where the mountain sides are steep, to an extent not always fully appreciated.

The effect of the taper and reversing tangent in increasing cost of construction is indicated by the resulting distances in a direct line between the centers of the corresponding main curves, as compared with the sum of the main curve radii, the difference of these distances indicating the horizontal distance to be disposed of in excess of the absence of horizontal distance required by reversed curves without tapers and without reversing tangents.

The greatest effect of this sort results from the use of flatter tapers, indicating more benefit with the same expenditure in construction from longer reversing tangents than from flatter tapers.

In illustration, two 6° curves with tapers commencing with 30 ft. of 1° curve and with 120 ft. reversing tangent will have their centers separated by a distance of 21.7 ft. in excess of the sum of their radii; and two 6° curves with tapers commencing with 30 ft. of 30′ curve and with 120 ft. reversing tangent will have their centers separated by a distance of 63.1 ft. in excess of the sum of their radii, resulting in the latter case in a distance of 41.4 ft. horizontal to dispose of in the last example in excess of that in the first example, which 41.4 ft. might result in prohibitive or at least in extravagant cost of construction.

These extra horizontal distances to dispose of, for instance in a river gorge, would mean part or all of the distance more than otherwise necessary used in placing the center line of the railroad more into the river-flood exposure or more into the mountain sides in cutting or tunneling, and in close localities might give excessive cost of construction without increasing the suitable speed of trains for that locality—all of which indicates the need of conservatism in deciding on the financially appropriate taper-curve rate.

Activated Sludge Defined—The best definition of the activated-sludge process of sewage treatment which he has ever seen, said T. Chalkley Hatton, chief engineer of the Milwaukee Sewerage Commission, in a paper read before the Indiana Engineers' Society on Feb. 3, is the one given by William R. Copeland, chief chemist for the Milwaukee Sewerage Commission, and is as follows: "The sludge embodied in sewage and consisting of suspended organic solids, including those of a colloidal nature, when agitated with air for a sufficient period, assumes a flocculent appearance very similar to small pieces of sponge. Aërobic and facultative aërobic bacteria gather in these flocculi in immense numbers—from 12,000,000 to 14,000,000 per c.c.—some having been strained from the sewage and others developed by natural growth. Among the latter are species which possess the power to decompose organic matter, especially of an albuminoid or nitrogenous nature, setting the nitrogen free; and others, absorbing this nitrogen, convert it into nitrites and nitrates. These biological processes require time, air and favorable environment, such as suitable temperature, food supply and sufficient agitation to distribute them throughout all parts of the sewage." The activated-sludge process, Mr. Hatton points out, should not be confused with the kind of artificial aëration of sewage, attempted from time to time in the past, which made no use of the sludge, as an aid to oxidation. The new process, Mr. Hatton states, "preserves the aërobic bacteria by keeping the sludge, which is their natural food, in intimate contact with air at all times and keeps them supplied with fresh food from the raw sewage, throughout the whole body of which they are in intimate contact."

Drainage Engineering*

By John T. Stewart†

For the low regard with which engineering work is held in the agricultural community the engineer is to a certain extent responsible. He has not exerted himself to raise the standard of his profession or to enlighten the communities in regard to the value of securing competent men for improvement work. The agriculturist has considered all engineers of the same grade and classed them according to price per day. As a result much poor work has been done, and the agriculturist, not getting the results he anticipated, has grown to look upon the term engineer as synonymous with large expenditures and inefficient results.

The engineer is at fault also in not making it clear to his clients that his fees are not charged for looking through a telescope, but that the transit and level are only an incident to the work and that the fee is charged for the training and judgment which the engineer possesses and uses for the benefit of his client.

The engineer, particularly in the farm community, could well afford to give some education on the value of competent engineering services. In the states which were first to adopt improved methods of land drainage, engineers' offices have been developed which are making a specialty of this line of work and are receiving fees for it that are commensurate with fees in other lines of engineering.

Until the engineer can show conclusively to the agricultural community that his services are economical and are the means of saving money and increasing wealth, there will be little demand for such services in land improvement. Modern demand for improved lands that will reach their highest producing possibilities in a short time, the rapid advance of farm methods and the scientific management of such lands are rapidly bringing the agricultural communities up to the point where only first-class improvements will be acceptable and proper engineering services cheerfully paid for.

Value of Drainage and Land Improvement

Our land-improvement work has been carried on to a certain extent under a wrong impression. When any improvement that has a tendency to increase production is under consideration, everyone talks about special assessments, additional taxes, etc. This is not the light in which such improvement should be considered, unless we want to hold that the original purchase price of a tract of land is a tax or special assessment. If landowners could be induced to see the final results and gains, it would cause a change in opinion as to the value of engineering services.

The whole tendency in drainage engineering at the present time is for the use of better materials, permanent construction and increased efficiency. To accomplish this result, reputable engineers are being called on to make designs and review plans without regard merely to the actual fee per day that will be charged for such services. The cheap, inadequate construction of days past is rapidly disappearing, although it will be continued in the newly developed areas for some time, and there is still room for educational work.

The general aversion of the landowner to an unsightly ditch across his fields is causing the small open ditch to be replaced by underground conduits. This construction results in a demand for increased sizes of tile, oftentimes at an expense that from an economic standpoint would hardly seem justifiable. The design and construction of such drains, to get them efficient without being unduly expensive, call for engineering skill far in advance of that required 20 years ago, when a 12- or a 15-in. tile was the "big drain."

The making of tile of large diameter without taking into consideration the load to be carried has led to many failures. The trouble became so great that the tile factories and tile contractors almost demanded that methods and specifications be prepared by which drain tile could be tested and classified like other construction materials. The American Society for Testing Materials appointed a committee in 1912 to prepare specifications for methods of testing drain tile. Its work is not yet completed, although several tentative reports have been made.

Segment Blocks for Drains

There is a limit to the size of clay or cement pipe that can be built in a factory, transported and laid in a trench. Apparently we were near the limit of the size of conduit for drainage work, when the segment block appeared. It was readily made, easily transported and laid; and the claim was made that it had the strength to carry the required loads. It is rapidly coming into general use throughout the Middle West for sewer work and is the coming material for drainage work for conduits above 30 in. in diameter.

While the form of the first blocks was patented, other forms are coming on the market. The cement men will probably furnish a similar block, and the competition will be sufficient to prevent a monopoly of any one patent.

It has been common practice to decide on the location of a ditch, determine its bottom width, give it 1:1 slopes and proceed to construct. In many instances the area of the watershed has been entirely neglected. No consideration has been given to the effect of this construction on the stream or channel into which it discharges and no provision made for change of grade in the channel or for the inlet of surface water from either side. Road ditches whose bottom elevation is 3 or 4 ft. above that of the main channel are left just as the dredge finds them. Breaks are made in the spoil banks, through which dead furrows and open channels lead. If no break is made, water piles up behind the spoil bank and works its way to the nearest road ditch and then comes into the main channel with a rush, carrying dirt and débris.

In many cases a ditch would be run practically level; then the grade would change to 1% and then again to 0.1%. The changes were made for economy in construction, to prevent deep cutting and still hold to a required depth. There was a time when irrigation ditches were constructed along the same lines, but it has been found economical where there is a rapid change of grade to make the change short and to place at that point a drop, or permanent structure for lowering the water. There are many localities on drainage districts where the change of grade could be made more economically by a permanent drop than by alternately changing from flat to high grades. It has been found economical to line irrigation channels around sharp curves or through soil that erodes easily.

*Extracts from a paper read at the annual meeting of the Minnesota Surveyors and Engineers Society, St. Paul, Minn., Feb. 11.

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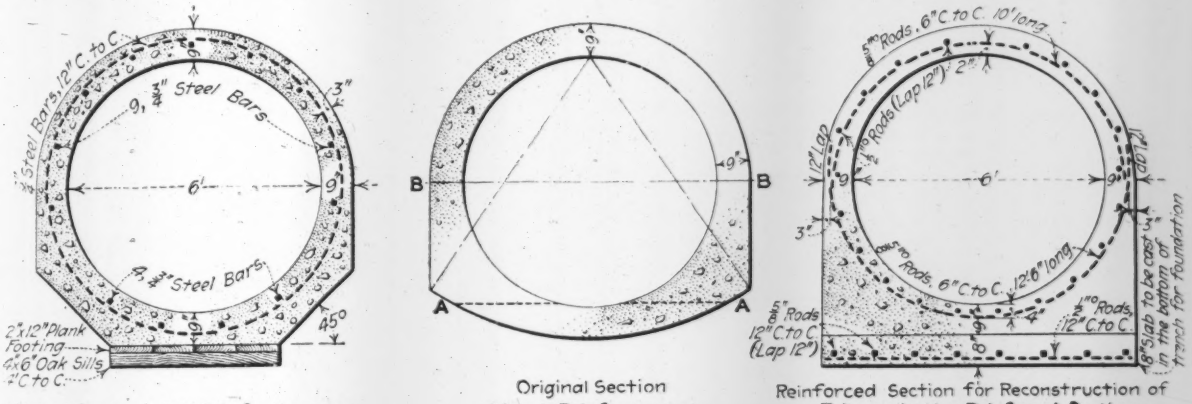
and this practice will apply also to drainage channels. Steel piling and concrete walls are being used in levees and irrigation ditches, and the time is rapidly coming when they will be used in drainage work.

Failures in a 6-Ft. Concrete Sewer at Cairo, Ill.

Failures, or breaks, in a 6-ft. concrete main sewer have caused trouble at Cairo, Ill. One of the most serious of these failures occurred in December, 1915. The Commercial Ave. sewer leads to a pumping station where, at periods of high water in the river, the sewage is raised and discharged. The heavy pumping results in an external pressure on the sewer (with suction at any cracks). All the failures have been in parts of the sewer built without steel reinforcement. As a result of this experience all the newer and the repaired parts of this main sewer are of reinforced concrete. The original sections and the section used in reconstruction are shown in the accompanying drawing. The information was furnished by George F. Dewey, city engineer.



SECTIONS OF 6-FT. MAIN SEWER AT CAIRO, ILL., PARTS OF WHICH FAILED

Failures occurred in the section without reinforcement

While other parts of the sewer were still under construction, two breaks occurred in Commercial Ave. in 1909—150 ft. at 14th St. and 100 ft. at 15th St. They were repaired by the contractor, using the original section. Two breaks occurred in March and April, 1912—250 ft. at 14th St. and 175 ft. at 13th St. These were rebuilt by the city, using reinforced concrete; and the cost (less the reinforcement) was recovered from the contractor, as his guarantee did not expire until August, 1912.

In the spring of 1915 an examination showed that for 45 ft. south of the 13th St. break of 1912 the plain concrete sewer was shattered all over, but still holding in place. Excavation was started, in the expectation that by July the river would be low enough to permit the completion of the work, but the river reached a working stage for only three weeks during the remainder of the year. Pumping was done repeatedly, the water passing through the defective part of the sewer.

On Dec. 24, while pumping was in progress owing to the heavy rise in the rivers, this part of the sewer collapsed (between 12th and 13th St.); and considerable earth caved in before the damaged part could be shut off by bulkheads. They were placed at 11th and 13th St., after which pumping was resumed to relieve the sewers in other parts of the city. This break was in the largest section of the main concrete sewer and only 1,000 ft. from the main-sewer outlet and pumping station at 10th and Ohio St., near the river.

The bulkheads consisted of expanding circles placed across the sewer and wedged tight. The side next to the break was sheathed with 2-in. plank and covered with two courses of canvas, after which sacks of manure were placed against the bulkhead to the full height of the sewer, backed up by sacks of dirt. This formed an effective stop. The bulkheads were placed so that the pumping station at 10th St. could handle the flow from all sewers south of the break, while the other parts of the city were handled by the 28th and 38th St. pumping plants.

The flow line of the sewer at the break was 19 ft. below the surface of the paved street; bottom of concrete, 8 in. lower. The fracture, while originally 45 ft. long, has extended to about 125 ft. The effect of the settlement of the material immediately around the sewer is shown at the surface for a distance of 25 ft. east of the sewer line and 35 ft. on the west side. Loose earth and sacks of earth were placed in the cavity to offset the tendency of material to slough in from the sides, so as not to endanger the foundation of a building on the west side of the street.

The unreinforced part was built in 40-ft. sections. The base was poured first, up to line *AA*. Then the invert form was set on this; and the sides were poured up to *BB*, after which the arch was poured. Each section took its initial set before the next was applied. There were no dowels or reinforcing to connect these parts or to connect the 40-ft. lengths. The flow line is 18 to 19½ ft. below the street. A clay stratum extends down to the springing, below which is coarse and fine sand only, with some quicksand.

Mr. Dewey states that there would have been no difficulty in handling the water, but that there was 4.2 in. of rainfall in 48 hr., besides other lighter falls and the seepage water. In addition, there were 5,000,000 gal. pumped for the water company and 2,500,000 gal. pumped by the traction company from the Ohio River for condensing purposes, this water going back to the sewers. Fortunately, the low areas were able to hold this excessive rainfall, and only a few basements were flooded.

Engineering Literature

Military Reading Course for Civilian Engineers

On account of the widespread interest in the lectures on military engineering now being delivered at New York City under the auspices of the national engineering societies and because of the desire of many engineers throughout the country to inform themselves on military art and science, the short reading list appended to an editorial note in *Engineering News* of March 9, 1916, p. 473, is here followed by a list of sufficient length to meet the wants of the most zealous civilian advocate of preparedness.

The brief list already given was largely based on one prepared by the Chief of Engineers, United States Army, in response to frequent requests. The few books mentioned in that list will afford a convenient start in the more extensive reading course recommended by the Chief of Engineers.

He states that these references have been selected, first, with a view to giving to engineers a general survey of the art of war—an understanding of which is essential to the application of engineering knowledge to military purposes—and second, to set forth the ways in which engineering is applied. Military art and engineering are progressive, and a considerable part of the latest information is available only in the army service journals. This is particularly true of technical details of seacoast defense, field artillery, military aviation and their influence on military engineering. It is believed, however, that the fundamentals of each subject are well covered by the references given in this list. The books marked with an asterisk are those already mentioned as the first to be read.

ON MILITARY POLICY, CONDUCT OF WAR AND HISTORY

Group 1

1. Official Bulletin, Vol. I, No. 2—Office of the Chief of Staff, Washington, D. C. (Especially pp. 21-39.) Army War College, Washington, D. C.; free. (An official outline of the theory under which our forces are to be organized and administered.)

2. Military Policy of the United States—Upton. Superintendent of Documents, Government Printing Office, Washington, D. C.; paper, 50c.; cloth, 65c. (A most valuable and comprehensive review of this subject.

*3. Field Service Regulations, 1914—Superintendent of Documents; 60c. (A condensed official statement of principles, methods and details of military operations.)

*4. Elements of Strategy—Fiebeger. United States Military Academy; Book Department, Army Service Schools, Fort Leavenworth, Kan.; 75c. (A short outline, with historical illustrations.)

Group 2

5. Conduct of War—Von der Goltz; translated by J. Dickman. Hudson Publishing Co., Kansas City, Mo. Book Department, Army Service Schools, Fort Leavenworth, Kan.; $1.70. (The standard work on this subject, covering generally the same ground as 4, but more abstractly and elaborately.)

6. On War—Clausewitz; translated by J. J. Graham; 3 vols. K. Paul, Trench, Trubner & Co., 1908. Book Department, Army Service Schools, Fort Leavenworth, Kan.; $6.60. (The greatest classic on the subject; a complete analysis of the phenomenon of war and profound discussion of the mechanism thereof. Written early in the nineteenth century, it is still the foundation of modern military theory.)

7. American Campaigns—M. F. Steele; 2 vols. Byron S. Adams Publishing Co., Washington, D. C. Book Department, Army Service Schools, Fort Leavenworth, Kan.; $4.50. (In addition to careful historical surveys of all the campaigns from the Colonial Wars to the Spanish-American War, these lectures give extensive and valuable comments as to the military principles.)

8. A Study of Attacks on Fortified Harbors—Rodgers. Proceedings Nos. 111, 112 and 113, United States Naval Institute, Annapolis, Md.

9. Lessons of the War with Spain—Mahan. Little, Brown & Co., Boston, Mass. Book Department, Army Service Schools, Fort Leavenworth, Kan.; $2. (Of special importance, as showing the true relation between our coast defense and our navy.)

10. Reports of Military Observers on the Russo-Japanese War. Part III—J. E. Kuhn. Superintendent of Documents, Washington, D. C.; 60c. (In addition to an account of operations, this report contains valuable information as to fortification and siege work, organization and equipment.)

11. Organization and Operation of the Lines of Communications in War—Furse, 1894. William Clowes & Sons, Ltd., London. (An old but comprehensive survey of this subject with much historical information.)

ON PERMANENT FORTIFICATIONS

Group 1

12. Report of National Coast Defense (Taft) Board, 1906—Army War College, Washington, D. C.; free. (The official project for harbor defenses of the United States. On account of progressive obsolescence of seacoast defenses this project has been or is being modified, but still sets forth clearly the fundamentals of its subject.)

Group 2

13. Lectures on Seacoast Defense—Winslow. United States Engineer School, Washington Barracks, D. C.; 50c. (Much of these lectures relates to technical details, and a considerable part is now obsolete.)

14. Permanent Fortifications—Fiebeger, 1900. United States Military Academy, West Point, N. Y. Book Department, Army Service Schools, Fort Leavenworth, Kan.; $1. (While rather old, this work gives a simple presentation of the fundamentals on its subject, including a historical outline. A revised edition will soon be published.)

15. Fortification—C. S. Clarke. Dutton & Co., New York. Book Department, Army Service Schools, Fort Leavenworth, Kan.; $4.50. (A treatise on the same lines as 14.)

16. Principles of Land Defense—Thuillier, 1902. Longmans, Green & Co. Book Department, Army Service Schools, Leavenworth, Kan.; $3.83. (A very valuable work, covering the principles of both field and permanent fortification.)

ON ORGANIZATION, EQUIPMENT AND DUTIES OF ENGINEER TROOPS

Group 1

*17. Field Service Regulations, 1914. (See 3.)

18. Tables of Organization, 1914—United States Army. Superintendent of Documents, Washington, D. C.; 25c. (These tables represent—subject to modification and within the limits of existing law—the approved policy of the War Department with regard to organization.)

19. Official Bulletin, Office of Chief of Staff, United States Army; Vol. I, No. 4 (Appendix 4), Use of Engineer Troops—Army War College, Washington, D. C.; free. (An official statement of the principles which should govern in the use of engineers, with practical suggestions.)

20. Duties of Engineer Troops in a General Engagement of a Mixed Force—Burgess. United States Engineer School, Washington Barracks, D. C.; 25c. (Obsolete in some respects, particularly organization, but excellent in general scope.)

21. General Orders No. 6—War Department, 1915. Adjutant General, United States Army, Washington, D. C.; free. (Prescribes the training of engineer troops.)

Group 2

*22. Studies in Minor Tactics—Army Service Schools, 1915. Book Department, Fort Leavenworth, Kan.; 50c. (The principles of minor tactics are set forth by solution of a series of problems.)

23. Technique of Modern Tactics—Bond & McDonough, 1914. Banta Publishing Co., Menasha, Wis. Book Department, Army Service Schools, Fort Leavenworth, Kan.; $2.55. (This work covers, in a very specific way, the principles of tactics for all arms, a general knowledge of which is essential for engineers.)

24. Operation Orders—Von Kiesling; translation. Book Department, Army Service Schools, Fort Leavenworth, Kan.; 50c. (A lucid exposition, by use of assumed cases, of the operation of highly trained troops of all arms in various phases of battle.)

25. Engineer Unit Accountability Manual—Superintendent of Documents, Government Printing Office, Washington, D. C.; 5c. (Official lists of standard equipment supplied to engineer battalions and companies.)

26. Organization of the Bridge Equipage of the United States Army, 1915. (Revised edition just going to press.) (Includes description of equipage and regulations for pontoon drill.)

27. Officers' Manual—Moss. Banta Publishing Co., Menasha, Wis. Book Department, Army Service Schools, Fort Leavenworth, Kan.; $2.50. (Treats of routine duties of officers, customs of the service, army organization, etc.)

28. Manual for Courts Martial—Superintendent of Documents, Government Printing Office, Washington, D. C.; 50c.

ON FIELD ENGINEERING

(Military field engineering at the front differs from ordinary engineering work in the field in being generally simpler, of a rough-and-ready character and especially because of the limited equipment which can be taken along with the advance of an army and because of the necessity of working in strict subordination to the military situation. In the rear of the army, on the contrary, conditions are very similar to those

governing ordinary engineering operations, and civilian organization is suitable, subject to directions by the higher military staff. Little attempt is made in works on military field engineering to treat of general engineering methods.)

29. Field Fortification—Fiebeger, 1913. J. Wiley & Sons, New York. Book Department, Army Service Schools, Fort Leavenworth, Kan.; $1.90. (In addition to technical details this work gives valuable historical illustrations of the principles of this subject.)

30. Field Entrenchments, Spade Work for Riflemen—John Murray, London. Book Department, Army Service Schools, Fort Leavenworth, Kan.; 40c. (A very uptodate little work, especially on details.)

*31. Notes on Field Fortifications—Army Field Engineer School. Book Department, Army Service Schools, Fort Leavenworth, Kan.; 30c.

*32. Engineer Field Manual—Professional Paper No. 29, Corps of Engineers, United States Army; 3d edition, 1909. Superintendent of Documents, Washington, D. C.; $1. (A very complete official pocketbook for engineer officers in the field. Part I, Reconnoissance; Part II, Bridges; Part III, Roads; Part IV, Railroads; Part V, Field Fortification; Part VI, Animal Transportation. A new revision of the manual is contemplated, but will not be ready within a year. The portion of the manual relating to field fortification, being somewhat obsolete, should be considered in connection with either 30 or 31. The portion relating to railroads is largely superseded by 35.)

33. Notes on Bridges and Bridging—Spalding. Book Department, Army Service Schools, Fort Leavenworth, Kan. (A small pamphlet on military bridging.)

*34. Military Topography for Mobile Forces—Sherrill. 2d edition. Banta Publishing Co., Menasha, Wis., 1911. Book Department, Army Service Schools, Fort Leavenworth, Kan.; $2.25. (Besides matter given in ordinary textbooks on surveying, this work gives in detail the special methods of sketching developed in the army for rapid military mapping.)

*35. Military Railroads—Connor; Professional Paper No. 32, Corps of Engineers, United States Army. Superintendent of Documents, Washington, D. C.; 50c. (Intended to cover general administration of existing railroads for military purposes and the handling of railroads by military personnel in the advanced sections where railroads cannot be operated by their regular civilian organizations or where new railroads are required in the immediate vicinity of the army. Revised edition soon to appear.)

36. Notes on Military Explosives—Weaver. J. Wiley & Sons, New York, 1912. Book Department, Army Service Schools, Fort Leavenworth, Kan.; $2.20. (Elementary notes on this subject will be found in the Engineer Field Manual and other references cited. This work is more elaborate.)

MISCELLANEOUS WORKS

37. Regulations for the Army of the United States—Superintendent of Documents, Washington, D. C.; 50c.

38. The Volunteer Law, approved Apr. 25, 1914; Bulletin No. 17, War Department, 1914—Adjutant General, United States Army, Washington, D. C.; free.

39. General Orders No. 54, War Department, 1914—Adjutant General, United States Army, Washington, D. C.; free. (Covers examination of candidates for commissions as officers of volunteers.)

40. General Orders No. 50, War Department, 1915—Adjutant General, United States Army, Washington, D. C.; free. (Amends General Orders 54, 1914, as to examination of candidates for commissions in volunteer engineers.)

41. Treatise on Military Law—Davis. J. Wiley & Sons, New York. Book Department, Army Service Schools, Fort Leavenworth, Kan.; $5.30.

42. Elements of Military Hygiene—Ashburne. New edition. Houghton, Mifflin & Co., Boston, 1915. Book Department, Army Service Schools, Fort Leavenworth, Kan.; $1.30.

ARMY SERVICE PERIODICALS

43. Professional Memoirs, Corps of Engineers, United States Army, and Engineer Department at Large—Bimonthly (formerly quarterly). Engineer Press, Washington Barracks, D. C.; per year, $3.

44. The Royal Engineers' Journal—Royal Engineers' Institute, Chatham, England; monthly; per year, $4. (American agents, E. Steiger & Co., 49 Murray St., New York.)

45. Journal of the Military Service Institution—Bimonthly. The Institution, Governors Island, New York; per year, $3.

46. Journal of the United States Artillery—Bimonthly. Coast Artillery School Press, Fort Monroe, Va.; per year, $2.75.

47. Journal of the United States Cavalry Association—The Association, Fort Leavenworth, Kan.; per year, $2.50.

48. Infantry Journal—United States Infantry Association, Union Trust Building, Washington, D. C.; per year, $3.

49. Field Artillery Journal—United States Field Artillery Association, 601 Star Building, Washington, D. C.; per year, $3.

*50. Infantry Drill Regulations—Superintendent of Documents, Government Printing Office, Washington, D. C.; 60c.

*51. The Service of Coast Artillery—Hines and Ward. Goodenough & Woglam Co., 122 Nassau St., New York City; $3.50.

CORRESPONDENCE

Standard Sewage-Works Terms

Sir—The "Need of Standard Terms in Sewage-Disposal Work," brought out by John H. Gregory in your issue of Feb. 17, is a matter of interest to many sanitary engineers. When one man speaks of a rack and another speaks of the same device as a screen it is confusing to the layman, if not to the engineer.

With regard to screens the Germans distinguish between different types by the words *rechen* (rakes or racks), *sieben* (sieves), *separatorscheiben* (perforated plates), *abfischgitter* (band of links for raising floating material from the sewage), etc., which usually suggest the form or function of the article. In English the screens are usually classified indiscriminately as coarse or fine.

The writer favors the single term screenings for the product of such devices (certainly not rackings or gratings), as this product does not differ with the type of screen so much as with the character of the sewage; but regarding screens themselves, there should be some authorized terms to distinguish the several types, as has been referred to by Mr. Gregory.

There is a similar difference in the terms settling tank and sedimentation basin; dosing tank and dosing chamber; disinfection and sterilization; sand catcher, grit chamber and detritus tank; purification, treatment and disposal, etc., from which one might infer a difference in meaning or function, when none was intended.

As to the term Emscher tank (*Emscherbrunnen*), that has been the term in general use in Germany and was at first the one in common use here, although within the past few years this type of tank has in America been more frequently called after the inventor—Dr. Imhoff.

The suggestion to standardize such terms as those mentioned is a good one and might well be taken up by the Sanitary Engineering Section of the American Public Health Association and the Sanitary Section of the Boston Society of Civil Engineers—jointly, if possible—together with other terms connected with sanitary engineering, as suggested in the article referred to.

KENNETH ALLEN,
Engineer of Sewage Disposal, Board of Estimate.
Municipal Building, New York City, Feb. 18, 1916.

Titles for, and Indexes of, Engineering Articles

Sir—The writer, like other engineers, has had difficulty in locating articles in completed volumes of engineering periodicals with the aid of the usual index. This is particularly true of articles that have been read at the time of publication, some particular feature of which, rather than the title, has left a lasting impression on the reader's mind. Later, when endeavoring to locate the article, one naturally searches in the part of the index where that feature would properly be listed, but too often without success.

As an example: If in an article descriptive of a new railroad line various types of structures were illustrated and described and then indexed under the very general heading "The Fruitvale Extension of the A. B. C. Ry.," the chance of finding them would depend entirely upon the reader's memory. The more important technical journals have long since realized this fact and index articles under various headings, but improvements are still possible.

The great multitudes of journals with a comparatively small circulation pay very little attention to indexing, most of them being content to give simply an alphabetical title index of articles. This practice leaves the bound volumes of such papers practically useless, and as a result very few engineers go to the expense of having them bound. The value of a technical journal is measured by

the completeness of its volume index. If a volume is not worthy of a good index, it certainly is not worth having.

Accepting the fact that some editors will not prepare good indexes on account of the labor involved, a partial solution can be obtained by the careful selection of titles for articles. This means that sensational newspaper headlines are out of place in a technical journal and that the title should convey the main key-words of the article, such as the name, type and location of the work described. A title such as "The World's Longest Arch Span" may be very attractive at the time of publication; but five years hence, when the structure no longer ranks as such, this title in an index is entirely misleading, since it may call to mind an entirely different structure, whereas had the name of the structure been included in the title, no such misunderstanding would arise. If, however, editors wish to use titles and headlines to attract the reader much in the same manner as newspaper headlines, the subject should be properly indexed and cross-indexed in the volume index, to preserve its reference value.

In order that a reader may readily find the subject he is searching for, it seems reasonable that the various subjects should be indexed under the main classification heading or idea, which in turn is divided into the various subclasses or ideas. For example, instead of merely listing descriptions of various buildings under the heading "Buildings," they should be listed under materials and again under type, such as flat slab, beam and girder, etc. (this for concrete buildings).

The writer has never seen an index quite as elaborate in outline as the one here suggested; but since the technical journals claim to have as one of their aims the furnishing of aid to the engineer in solving his problems, it would not seem out of place for them to index their volumes with more exactness than is now the rule.

What has been said regarding indexes for technical magazines applies with equal force to engineering books, a great many of which are poorly indexed. Some excellent works are marred, their usefulness hampered and the sales materially reduced by an insufficient and poorly arranged index. ALBERT M. WOLF.

Chicago, Ill., Feb. 27, 1916.

Expert Dealer in Second-Hand Engineering Books

Sir—In *Engineering News* for Feb. 17 there appeared an article entitled "Expert Dealer in Second-Hand Engineering Books." By those in charge of technical departments of public libraries and of engineering books in large offices the outcome of the suggestion that some engineer enter this field will be watched with interest.

In public libraries I doubt if there would be a great field for the proposed idea. Such volumes as would be offered for sale would, by virtue of the fact that they are of no more use to the library, seem to be of no value to the engineer. I have today in storage stacks over 400 books that are either superseded by later editions or that have outlived their usefulness. However, among the books offered to the market from a public library there might be volumes of peculiar interest to some engineers.

While I say that books of the kind just named are practically the only ones offering themselves for a second-hand market, there are at times "overflow" books—duplicate copies bought to supply a demand for more than one copy of the publication, but no longer needed. These books are deadwood. The librarian would welcome a possible market for them.

The field for back numbers of technical periodicals might prove fertile ground for an engineer to work in, where the International Magazine Co. and Boston Book Co. are not felt.

In this city I hope to index the people who subscribe to engineering periodicals that we do not take or that the university library lacks and note who are willing either to lend copies of their periodicals to brother engineers unable to get them or, if possible, to have those who subscribe to the magazines found in the canvass deposit odd copies, or copies that they wish no longer, in this library.

In short, if the scheme works out, the library aims to serve as a "Where to Look Bureau" for technical periodicals in the city and a clearing house for such, if possible. KENNETH C. WALKER,

Head Department of Technology,
Free Public Library.

New Haven, Conn., Feb. 19, 1916.

REVIEWS AND NOTES

Irrigation Practice

REVIEWED BY H. B. MUCKLESTON*

IRRIGATION PRACTICE AND ENGINEERING: Vol. I, Use of Irrigation Water and Irrigation Practice; Vol. II, Conveyance of Water; Vol. III, Irrigation Structures and Distribution System—By B. A. Etcheverry, Head of the Department of Irrigation, University of California. New York: McGraw-Hill Book Co. Cloth; 6x9 in.; pp. xiii + 213; xviii + 364 and xv + 438; 77, 82 and 186 illustrations. $2, $3.50 and $4 net.

The author states in his preface that this work is intended to fill the needs of teachers and students in technical colleges and to serve as a work of reference for engineers and managers of irrigation projects. It is in three volumes, of which the first deals entirely with the use of water on the irrigated farm and the other two with the design and construction of the system that delivers the water to the farm.

In the preface to the first volume, the author says that the designing engineer should have some practical knowledge of the agricultural phase of the problem. That this is an important matter is shown by the many irrigation failures which can be traced to the lack of just such knowledge on the part of the designing engineer.

Volume I opens with a chapter on the relation of soil moisture and plant growth and their bearing on irrigation practice. The chapter treats of the forms in which soil moisture occurs, the optimum percentage and the wilting coefficient, of soil moisture before and after irrigation and the feeding zone of plant roots. Consideration is next given to the disposal of irrigation water by transpiration, soil evaporation, deep percolation and surface waste and to the water requirements for various crops.

The time and frequency of irrigation for different crops, as governed by the varying factors of character of soil, amount of natural precipitation, soil and water

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temperature and soil-moisture condition during the irrigating season, are then discussed. The author states that the irrigation season may have to be adjusted to the available supply of water. He might have said with equal force that the character of crops may have to be similarly adjusted.

That much overworked term, "the duty of water," is next taken up. The author gives, as a commonly used definition, the relation between the area of land served and the quantity of water used and follows this by stating how the term is qualified in practice, as gross or net, or as measured at some intermediate point, such as the heads of laterals. Except in certain states where the meaning is fixed by statute, the term "duty of water," unless qualified, has no definite meaning, and its use alone is sure to lead to confusion, if not worse. It is desirable that the words be used in one sense only and that new terms be found or invented for the others. The author missed an opportunity here.

The two chapters on the preparation of the land and distribution of water on the farm are the most valuable chapters in the volume, for however desirable it may be for the irrigator to have a knowledge of the subjects treated in the earlier chapters, he does not always see the necessity, whereas the actual application of water is something which he must learn; and usually he learns it by costly experience. The author handles this subject in much the same order as the farmer would have to do the work, beginning with the initial job of clearing the land and going on through the subjects of smoothing and leveling to the planning and construction of the farm distribution system and the various methods of applying the water. The author has drawn freely from the publications of the United States Department of Agriculture and the various state institutions and has supplemented this material by his own observations. There is a particularly good description of the method of water distribution by cement pipes—a method formerly peculiar to California, but which is now largely used in other states. The chapter contains well-selected illustrations and descriptions of the various farm-irrigation structures that may be required.

The volume concludes with a chapter on the selection and costs of small pumping plants. The relative merits and demerits of various pumps and motors are pointed out and advice given in weighing these for a decision. Some approximate prices, which may be used with caution in preliminary estimates, are given.

The material presented in this volume is largely a careful selection from the great mass of experimental data available. In most cases the source is given, so that those who wish to may follow the matter farther. The material is logically arranged, and the written matter is illuminated by a copious use of illustrations. The volume should be a valuable addition to the libraries of those who cannot afford the time or money necessary to read the larger and more voluminous works on the same subjects. As the book is designed as a work of reference, it would be improved by a more copious index.

Volume II is devoted to the design and construction of the conveying channels that bring the water to the farms, including flumes, pipes, siphons and tunnels. It opens with a chapter on the general features and investigations precedent to design, followed by a chapter dealing with the planning and location of the system. The hydraulics of design of canals, flumes, pipes, etc., are next considered. As usual in American texts, Kutter's formula for the flow in open channels is given to the practical exclusion of all others, and as a consequence there is the usual presentation of another new diagram for the solution of this complicated and cumbersome equation.

The silt problem, losses from canals and the design of canal sections are next taken up. The seventh chapter is a very complete presentation of the subject of canal linings and prevention of losses. Numerous examples are cited by description and illustration, and the question of methods and costs is very fully dealt with. This is a subject which most textbooks on irrigation seem to fight shy of or ignore, and this chapter is a refreshing change. The material presented is drawn from a wide range of examples covering all conditions.

Chapter 8 handles tunnels, retaining-wall canal sections and bench flumes. Chapter 9 deals with flumes and Chapter 10 with pipes and siphons. The latter, which is by far the longest chapter in the volume, is the only one in which design is treated from any other point of view than that of carrying capacity. In this chapter the design of pipes is handled from the hydrostatic point of view as well as the hydraulic.

Volume III treats of irrigation structures and distribution systems. The division between the second and third volumes is arbitrary, but not illogical; and if a division was necessary, the line chosen is probably as good as any. The volume begins with a long chapter on diverting weirs, followed by one on scouring sluices and other appurtenances and by a third on headgates and regulators. Spillways and escapes, sand and silt traps, cross-drainage works and grade-correction works are the next topics to be given attention.

Throughout the chapters on design the author makes little reference, except in Chapter 10, Vol. II, to the static or hydrostatic requirements. This may account for the nearly complete absence of any reference to the destructive action of frost on all structural work in northern climates and particularly so in irrigation structures.

A chapter of 26 pages is devoted to the design of distributary systems and methods or systems of operating. Emphasis is laid on the desirability of constructing the system complete to the boundary of the farm unit, the undesirability of utilizing natural channels as irrigating machinery and the paramount necessity of an adequate drainage system, either artificial or natural. In the second part of the chapter the various methods of operation are described, and the advantages and disadvantages of each are outlined. The chapter concludes with an excellent discussion of required carrying capacities in distribution systems, which contains some very pertinent suggestions based on practice.

The last part of this volume deals with check gates, lateral headgates and turnouts, bridges and culverts, special types of distributing systems, such as pipe, flume, etc., and a variety of devices that have been proposed for measuring irrigation water.

Most of the matter presented in Vol. II and Vol. III is a very careful and catholic selection from the best of modern irrigation practice. The author is to be specially complimented on the excellence of the illustrations and the wealth of references given for those who wish to pursue any subject farther. The works of other writers are freely cited, sometimes to disagree with them.

Reinforced-Concrete Formulas and Diagrams

REVIEWED BY LEON S. MOISSEIFF*

SIMPLIFIED REINFORCED-CONCRETE MATHEMATICS: Derivation of Simple, Universal Formulas and Application of Same to Beams, Columns and Arches with Nomographic Computing Device—By Melvin D. Casler, Assoc. M. Am. Soc. C. E. New York: D. Van Nostrand Co. Cloth; 5x8 in.; pp. vi + 66; illustrated. $1 net.

Since reinforced concrete has become widely used, the equations of flexure of beams generally established in engineering practice for this composite material have become a fruitful source for the derivation of tables and diagrams to facilitate the statical computations of these beams. It is not that, for instance, the formulas for the flexure of a rectangular beam, based on the now almost generally accepted assumption of straight-line distribution of stress in the concrete, present difficulty in computing the required values; on the contrary, they are quite simple. But observant students would soon notice that the inter-relation of values in the five equations covering most cases of the flexure of reinforced-concrete beams can be simplified with the aid of a coördinate system expressed in tables or in diagrams.

Thus the position of the neutral axis of a rectangular beam is a function of the reinforcing-steel ratio and the ratio of the coefficients of elasticity of the materials used. The steel ratio itself is, at the same time, a function of the unit stresses. This inter-relation of values, quite simple in itself, has set to work many an engineer and has produced a number of excellent tables and diagrams that serve well to shorten the labors of the designer.

The author adopts the generally used assumptions and in deriving the formulas separates the expressions containing a decimal coefficient denoted by x. This coefficient represents the ratio of the distance between the neutral axis and the steel in tension to the depth of the beam measured to the same reinforcing. The author thus obtains four expressions, all of which are functions of x as the only variable. He then computes the values of these four expressions for various values of x and tabulates them for ready use. By placing the corresponding values on one line, only one of the four has to be computed, and the others will be found on the same line.

The author then carries out the same idea graphically. He plots the values in four concentric circles, so that when any one of the values is given the others are found along a radial line.

The application of this method is well illustrated by nine examples covering most cases met in practice. The eighth problem illustrates a common case of a reinforced arch; and while it is theoretically correct, it brings out clearly the limitations of the author's graphic procedure in this instance. Due to the nature of arch action the tensile stress in the steel is the difference between the direct compressive stress and the tensile bending stress. It is well known to every engineer that the degree of accuracy required for values whose difference is used must generally be much higher than where their sum is to be obtained. In the example brought out in the book, on page 53, the area of steel required is computed at $a = 0.179$ for a value of $T = 0.165$. A slight difference in reading the plotted values, say $T = 0.166$, results in $a = 0.152$, or about 85% of the former value. Evidently this very common case is not suitable for the graphic procedure.

The author has succeeded in producing a neat little volume and has added to the labor-saving devices of the engineer, for which he deserves credit.

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Wisconsin Utility Regulation

REGULATION OF RAILROADS AND PUBLIC UTILITIES IN WISCONSIN—By Fred L. Holmes. New York: D. Appleton & Co. Cloth; 6x9 in.; pp. xi + 375. $2 net.

By giving a clear account of the aims, methods and results of public-utility regulation in Wisconsin, Mr. Holmes has outlined what good control is, or might be, generally in this country. It is universally admitted that the Wisconsin Railroad Commission has done pioneer work in developing right principles and reasonable practice, but probably few persons know precisely what has been accomplished or how it has been done. Mr. Holmes' book draws back the curtain for all who have not had the time to go back of it themselves. The author is in an advantageous position to review broadly the work of the commission, having been for some time a member of the state legislature and chairman of the assembly transportation committee. The book shows evidence of the friendly coöperation of the commission's experts; there are numerous collections of data which could not have been presented otherwise. The book will be of service to everyone having a part in the regulation of utilities anywhere and to the officials and engineers of the public-service companies as well.

The book starts off with a summary of the development of the Wisconsin railroad and utility laws and the building up of the commission and its bureaus. Next are noted the need of plant valuations and the developed processes of appraisal. What the commission holds to be a fair rate of return—covering interest, risk, wages of management and profits—is explained, and data are given as to what has been allowed at various times. Emphasis is placed on good service and the development of definite standards for railroad, water, gas, electric, street-railway and telephone service is interestingly described. There is a short chapter telling how a scheme of uniform accounts was developed, upon a basis of summary double-entry bookkeeping, to show assets and liabilities, revenues and expenses and the disposal of profits and losses.

One chapter is devoted to "depreciation." This is not a clear presentation of the topic, for the author first defines depreciation as the amount set aside to cover impairment of capital and then uses the term also to describe the actual reductions in plant value. The author has also swallowed the now well-known bookkeeping trick of the Wisconsin commission—figuring annual depreciation-indemnity less than the actual loss of capital, making up the difference under guise of interest on too large physical value and asserting that thereby the cost of providing against depreciation has been reduced. The experience of the commission in building up and using life tables for utility property is the important contribution of this chapter.

In a chapter on "Making Railroad Rates" the author at first puts the Wisconsin commission down as definitely committed to cost-of-service, distinguished from value-of-service, as the basis and lauds the ability of its staff properly to apportion the joint costs and overhead expenses over the complicated services of a trunk railway.

Later on, however, the author cites decisions that show that the commission used cost-of-service figures as a basis of departure below which charges ought not to go and above which value-of-service controls.

The adjustment of water, gas and electricity rates on the famaliar output-demand-customer basis occupies one chapter. Much is said historically about electric-railway service and equipment, but no large amount is given on street-railway rates. These details of electricity and gas rates are given in a further chapter, and explanations are offered (lack of necessity and difficulty) of the failure, to date, to work out quite so completely a scheme of scientific telephone rates.

Under the chapter heading "Water Utilities" is a discussion of the need of control over municipal-service departments, which soon runs into water-works regulation. There is considerable on the differing requirements of city supply and fire protection, supplementary to the earlier chapter on actual formulation of water, gas and electricity rates.

The beauties of the indeterminate-permit type of franchise are set forth in one chapter, and in another, existing control over the issuing of securities is discussed. A chapter is filled in portraying the steps incident to putting water powers under the Railroad Commission.

What has been noted herein does not show the entire scope of this most comprehensive work. There is still left a quarter of the text, giving definite data on the improvements that have been wrought in railway service and safety, betterments forced on municipal utilities, the failure of municipal control contrasted with the success of state regulation, progress of investments under state utility supervision and support of the commission by courts.

Telephone Valuation

TELEPHONE APPRAISAL PRACTICE—By J. C. Slippy, author of "Telephone Cables" and "Appendix A, Telephone Construction-Methods and Costs." Pittsburgh, Penn. (428 Oliver Building): The Author. Cloth; 6x9 in.; pp. 97. $4.

It is a sign of engineering progress when new technical papers and books leave behind the general discussions of valuation—the many-times threshed "principles"—to present detailed methods and specific results in a limited field like telephony. Mr. Slippy's little book therefore will find a welcome in many an engineering library—partly because it gives specific procedure and data and partly because the telephone field is generally regarded a difficult one for an appraisal engineer.

The author's first few pages present certain definitions of fundamental terms for the orientation of the reader, who then is unceremoniously confronted with an outline of information that a commission usually needs in any telephone case—on general operation, plant value, finances. There are a few words upon the desirability of valuing on the basis of cost to reproduce and upon some of the incidental problems, like identical versus substitute plant, present versus original conditions, etc.

The work of making an inventory is developed by giving (1) a classification of fixed-capital accounts for a telephone utility, (2) blank forms for reporting plant items, (3) instructions about use of maps and forms, about desirable details, etc.

While the tabulation of unit costs is shown on the forms and their use is referred to in the pages so far mentioned, there is a whole chapter devoted to this matter. The labor and material costs of line construction in the Middle West are given separately and in detail.

A chapter is given up to "Depreciation," the author favoring the straight-line method—and apparently as a "repayment scheme," since depreciated value of physical property is cited as the final result.

Various life-data tables on telephone plant are compared. The final chapter reviews and summarizes the requirements of several commissions in telephone appraisal.

Analytical Mechanics

REVIEWED BY CLYDE T. MORRIS*

ANALYTICAL MECHANICS, for Students of Physics and Engineering—By H. M. Dadourian, Instructor of Physics in the Sheffield Scientific School of Yale University. Second edition, revised and enlarged. New York: D. Van Nostrand Co. Cloth; 6x9 in.; pp. xiv + 431; 148 illustrations. $3 net.

As stated in the preface, this book is based on a course of lectures and recitations given by the author to the junior class in electrical engineering at the Sheffield Scientific School. It has been enlarged about 80 pages from the 1913 edition by the insertion of a chapter on framed structures and graphic statics and by the addition of many problems. Parts of Chapters VI, VII and XII, on motion, have been rewritten.

The subject is presented largely from the physicist's viewpoint, especially the part on motion, which occupies 8 of the 16 chapters. The book contains nothing on the mechanics of materials, and in general the treatment is not particularly new. The mathematics of the latter half of the book might have been simplified in some cases by a little more detailed explanation.

At the beginning of the book is given a "Table of Notations," which is very useful and which insures a uniform notation throughout the work. From this table the meaning of any character in an equation can be found. Illustrative examples completely worked out are distributed through the text, and problems are given at the end of each chapter. These are very good.

Railway Maintenance Described

MAINTENANCE OF WAY AND STRUCTURES—By William C. Willard, Assoc. M. Am. Soc. C. E., Assistant Professor of Railway Engineering, McGill University. New York: McGraw-Hill Book Co. Cloth; 6x9 in.; pp. xxi + 451; 232 illustrations. $4 net.

Professor Willard's book is a useful addition to the rather limited literature on railway track and maintenance, although it follows largely on lines already covered. It is brought up to date, but goes rather outside its scope to deal with matters that have little relation to maintenance. The use of copious extracts from specifications and reports is hardly a commendable feature, as such matters can be and should be presented more effectively and much more concisely in a book of this kind.

The greater part is devoted to descriptions of equipment and appliances. The relatively small part on maintenance work treats mainly of ordinary routine details. Thus the matter on ditching refers to minor work done by hand and simply mentions the use of machines, without discussing the problems of handling ditching economically on lines of heavy traffic. Nor is

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there much information as to switchwork, sidings, terminal layouts, widening banks and cuts, renewing track in tunnels or the larger problems of maintenance work. Two special subjects not often discussed in technical books are taken up—namely, stresses in track and the design of track.

The index is so arranged as to waste considerable space, and although extensive, it is not systematic. For example, under "Bridge" there is no reference to "Inspection," "Maintenance" or "Painting," although these subjects are treated in the book. The 8-page detailed list of contents is a superfluity. The printing and illustrations are excellent.

Corrosion of Iron

REVIEWED BY FRANK B. SANBORN*

THE CORROSION OF IRON: A Summary of Causes and Preventive Measures—By L. C. Wilson. New York: The Engineering Magazine Co. [Works Management Library.] Cloth; 5x8 in.; pp. vi + 178. $2.

A book on the corrosion of iron is timely now that copper, brass and other noncorrosive metals are so high in price that engineers are utilizing iron as far as practicable. The book under review does not tell the engineer specifically when to use iron and when not to, but it will be a guide to him. It gives many facts about the rust problem—the causes of corrosion, protective measures that have been tried, the effects of ingredients of paints under many combinations to prevent rust, how to prepare or select the best paint for given conditions, the effect of the constituent elements of iron and of alloys in resisting rust and an analysis of the merits of wrought-iron and steel pipe.

The average engineer does not care to read an exhaustive treatise on these topics. He wants to get a quick insight into questions that should govern him in selecting proper materials. He looks for a short treatment alive with facts, clearly and concisely presented. He will find, the reviewer thinks, Mr. Wilson's brief treatise sufficiently comprehensive and technical, yet not intricate nor rambling.

Railway Rates and Regulation

RAILWAY REGULATION: An Analysis of the Underlying Problems in Railway Economics from the Standpoint of Government Regulation—By I. Leo Sharfman, Professor of Political Economy, University of Michigan. Chicago: La Salle Extension University. Flexible leather; 6x9 in.; pp. vi + 230. $2 postpaid.

Professor Sharfman's review of the railway rate and regulation situation is an admirable and concise presentation of a large subject, but necessarily is stripped of all but the most important details. The suppression of detail has accentuated the fundamental principles and outstanding features to be observed. Naturally and inevitably the result of trying to make such a book is essentially an epitome of the larger and older treatises, like Professor Ripley's "Railways: Rates and Regulations."

The author opens with familiar figures on the magnitude of the railway industry and with notes on its influence on the development of the nation. There is not much right here on the aggression of arrogant railway officials or on the growth of rank discrimination that led to popular demand for the proper suppression of utilities as public servants. But there are notes on the legal right to control (dealing with the public nature of the business) and the economic benefit (monopolistic nature of railways, self-destructive competition, chances for unfair influences, etc.). Having thus led up to the task and methods, the author drops back to present more in detail the history of railroading under private development and public aid, the evils of early speculation and the turn of public sentiment against the roads.

After a descriptive chapter on competition the "theory and practice of rate making" are taken up. Here "cost of service" and "value of service" theories are outlined, the desirability of using the one and the practical necessity of adopting the other showing up immediately. A few pages are given up to the classification of goods shipped and the adjustment of rates effected by the Interstate Commerce Commission.

In the rest of the book are traced the development in the courts of the right of the states to regulate roads and the gradual evolution of the powers of the Commission.

Making Ford Automobiles

REVIEWED BY ROSSITER R. POTTER*

FORD METHODS AND THE FORD SHOPS—By Horace Lucien Arnold and Fay Leone Faurote. New York: The Engineering Magazine Co. [Works Management Library.] Cloth; 7x10 in.; pp. x + 440; illustrated. $5.

The chapters of this book were published originally as a series of articles in the "Engineering Magazine." Collected here, they form a volume that must be of absorbing interest to almost anyone. By no means the least interesting is the first chapter, giving, among other things, Mr. Ford's personal history. Chapter II describes the Ford stock system and the employment methods. The remainder of the book takes up in detail different features of the production departments.

There are of course innumerable Ford innovations in automobile-manufacturing methods, which result more or less naturally from the truly stupendous output of more than 1,000 cars per day; but probably the most distinctive general feature of the production methods is the widespread use of conveyors, work-slides and rollways for moving materials in process of manufacture from one operation to the next. It is of interest to notice that there is clearly indicated the possibility of considerable further progress in reducing the cost of manufacture of the Ford car.

The book is well prepared and is freely illustrated, chiefly with excellent photographs. It all but leaves the reader with the impression that he has actually visited the Ford shops and studied them at first hand.

Much About Alloy Steels

MANUFACTURE AND USES OF ALLOY STEELS—By Henry D. Hibbard. Washington, D. C.: United States Bureau of Mines. Paper; 6x9 in.; pp. 72.

This most complete recent monograph on alloy steels should be in the hands of every structural and mechanical engineer. The author covers separately the various classes—simple tungsten, simple chromium, manganese, nickel, nickel-chromium, silicon, high-speed and chromium-vanadium. He gives figures of composition and properties, describes methods of production and discusses the chief uses, past as well as present.

*Consulting Engineer and Professor of Civil Engineering, Tufts College, Massachusetts. Professor Sanborn has been engaged during the past year in investigating and developing a commercial process of rustproofing iron and steel.

*Assistant Manager, Blood Brothers Machine Co., Allegan, Mich.

NEW PUBLICATIONS

[So far as possible the name of each publisher of books or pamphlets listed in these columns is given in each entry. If the book or pamphlet is for sale and the price is known by the editor, the price is stated in each entry. Where no price is given it does not necessarily follow that the book or pamphlet can be obtained without cost. Many, but not all, of the pamphlets, however, can be secured without cost, at least by inclosing postage. Persons who are in doubt as to the means to be pursued to obtain copies of the publications listed in these columns should apply for information to the stated publisher, or in case of books or papers privately printed, then to the author or other person indicated in the notice.]

AMERICAN RAILWAY BRIDGE AND BUILDING ASSOCIATION: Proceedings of the Annual Convention Held at Detroit, Mich., Oct. 19-21, 1915—Chicago (319 North Waller Ave.): C. A. Lichty, Secretary. Paper; 6x9 in.; pp. 389; illustrated. $1.

ANNUAL REPORT OF THE DEPARTMENT OF THE INTERIOR OF CANADA FOR 1914: Part VIII, Report of the Superintendent of Water Powers—Ottawa, Canada: Dominion Water Power Branch. Paper; 7x10 in.; pp. 309; illustrated.

ANNUAL REPORT OF THE MISSISSIPPI RIVER COMMISSION FOR 1915: Extract from the Annual Report of the Chief of Engineers, United States Army, for 1915—Washington, D. C.: War Department. Paper; 6x9 in.; pp. 215; illustrated.

ANNUAL REPORT OF NEW YORK STATE ENGINEER AND SURVEYOR FOR 1914; Vol. II, Report on Hydraulic Data, Department of the Barge Canal, Comprising the Fifteenth Annual Report on Stream Gaging—Albany, N. Y. Cloth; 6x9 in.; pp. 367.

CITY AND TOWN PLANNING CONFERENCE OF MASSACHUSETTS PLANNING BOARDS: Third Annual Conference, Held at Boston, Nov. 12, 1915, with the Homestead Commission—Boston: Henry Sterling, Secretary of the Commission. Paper; 6x9 in.; pp. 40.

CITY PLANNING: A Series of Papers Presenting the Essential Elements of a City Plan—Edited by John Nolen, Fellow, American Society of Landscape Architects. New York: D. Appleton & Co. [National Municipal League Series.] Cloth; 5x8 in.; pp. xxvi + 447; illustrated. $2 net.

COAL AND COKE—By Frederick H. Wagner, M. Am. Soc. M. E., Gas Byproduct Lecturer in Johns Hopkins University. New York: McGraw-Hill Book Co. Cloth; 6x9 in.; pp. xii + 431; 137 illustrations. $4 net.

THE COMMODITIES CLAUSE: A Treatise on the Development and Enactment of the Commodities Clause and Its Construction When Applied to Interstate Railroads Engaged in the Coal Industry—By Thomas Latimer Kibler, Professor of Economics, Agricultural and Mechanical College of Texas. Washington, D. C.: John Byrne & Co. Cloth; 6x9 in.; pp. 178. $3 delivered.

THE COMPRESSIBILITY OF NATURAL GAS AT HIGH PRESSURES—By G. A. Burrell and I. W. Robertson. Technical Paper 131. Washington, D. C.: Bureau of Mines. Paper; 6x9 in.; pp. 12.

THE DISPOSAL OF HUMAN EXCRETA AND SEWAGE OF THE COUNTRY HOME—By Theodore Horton, Director, Division of Sanitary Engineering. Albany, N. Y.: New York State Department of Health. Paper; 6x9 in.; pp. 18; illustrated.

ELEVATORS: A Practical Treatise on the Development and Design of Hand, Belt, Steam, Hydraulic and Electric Elevators—By John H. Jallings, Mechanical Engineer and Elevator Expert with Karstner & Hecht Co., Chicago. Chicago: American Technical Society. Cloth; 6x9 in.; pp. 217; 172 illustrations. $1.50.

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SEWERAGE: The Designing, Construction and Maintenance of Sewerage Systems—By A. Prescott Folwell, M. Am. Soc. C. E., Past-President, American Society of Municipal Improvements; Editor of "Municipal Journal and Engineer." Seventh edition, revised and enlarged. New York: John Wiley & Sons. Cloth; 6x9 in.; pp. x + 540; 46 illustrations. $3 net.

SMOKE ABATEMENT—By C. H. Benjamin, Dean of the Schools of Engineering, Lafayette, Ind.: Engineering Department, Purdue University. Paper; 6x9 in.; pp. 12; illustrated.

SPECIAL ASSESSMENT SECURITIES—An Address by Arthur E. Morgan, M. Am. Soc. C. E., President of the Morgan Engineering Co. [Reprinted from the Proceedings of the Engineers' Club of Dayton.] Paper; 6x9 in.; pp. 16.

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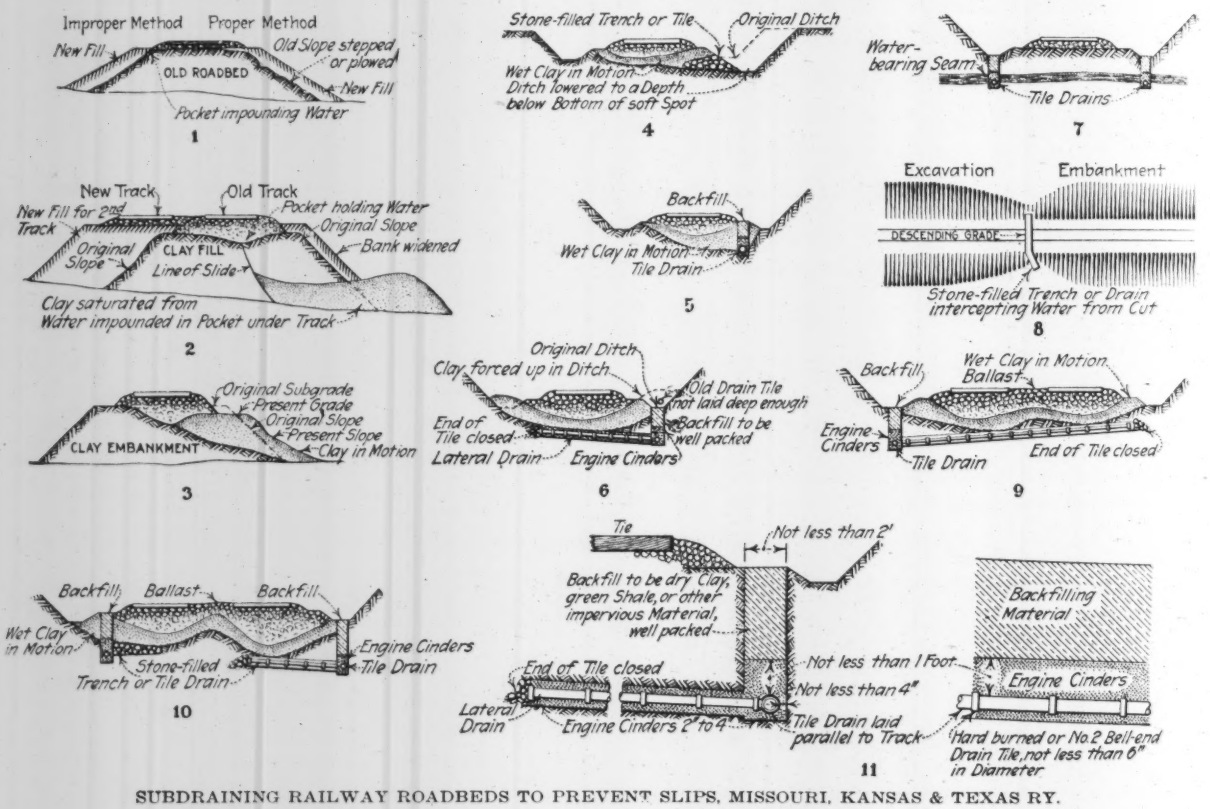
WATERWAYS OF NEW JERSEY: History of Riparian Ownership and Control Over the Navigable Waters of New Jersey—By Charles S. Boyer, Formerly Member of New Jersey Harbor Commission. Camden, N. J.: Sinnickson Chew & Sons Co. Cloth; 6x9 in.; pp. 295; illustrated. $2 postage prepaid.

Field and Office

Common Causes of Railway Slips and Their Prevention

During the recent flood conditions in the Mississippi Valley the Missouri, Kansas & Texas Ry. was one of the few railroads that maintained uninterrupted service to the Southwest. This record entitles its maintenance-of-way department to some credit and to some inquiry as to methods. The accompanying sketches and notes are based on an instruction sheet prepared in 1915 under the direction of Leon F. Lombladh, Chief Engineer, and on an interview with A. A. Matthews, Engineer of Maintenance-of-Way at Dallas, Tex.



SUBDRAINING RAILWAY ROADBEDS TO PREVENT SLIPS, MISSOURI, KANSAS & TEXAS RY.

A common cause of slips in embankment is illustrated in Fig. 1, where the fill has been widened without properly stepping the old slopes. This new fill of impervious material is often placed in such a way that the shoulders of the fill are higher than the old subgrade, forming pockets or troughs that retain water and cause soft spots in the track. Care should be taken to prevent this by removing the ballast from eroded or settled parts of roadbed and bringing the roadbed to grade with new material; the slopes of the old fill should be plowed before adding new material.

The same precautions apply to roadbeds widened for additional tracks and to widening roadbeds in fills. Two examples of the effects of faulty drainage in widened clay embankments are shown in Figs. 2 and 3. Transverse stone-filled trenches would have prevented these slips.

In cuts, when a soft spot does not extend to a great depth and the cut is shallow, it is economical to widen the cut, lower the side ditch to a depth below the lowest pocket and drain the roadbed into the ditch by means of a stone-filled trench or a tile drain (see Fig. 4). When soft spots have extended too deep to be economically drained by deepening the surface ditches, they should be drained by tiling laid parallel to the track and below the lowest part of the soft spot (see Figs. 5 and 6). In a cut where there is seepage from both sides, intercepting drains should be constructed on both sides of the track (Fig. 7); but if the seepage is from one side only, a single drain should be on that side.

Where there is probability of water from a wet cut entering an adjoining embankment, a tile drain or a stone-filled trench should be constructed across the roadbed near the end of the cut, to intercept the flow (Fig. 8).

Figs. 9 and 10 represent typical conditions of pocket formation in cuts and show the way drains should be laid to take care of such formations.

Fig. 11 gives in detail the method of laying and backfilling tile drains in cuts. Notice that these drains are

for subsurface water and are not intended to take the place of the side ditches.

Some general points to be borne in mind follow: Determine the depth of water in the pockets by digging a hole. Subdrains must always be laid below wet clay or below the lowest point in the pockets. If they are not so laid, they will not drain the pocket and will soon be displaced by slips. Trenches should be made as narrow as possible and should be braced during construction, if necessary. Drains parallel to the track should be laid as close to the track as the stability of the soil will permit and according to their depth, but they should never be nearer to the ends of the ties than 2 ft. The drains should have a fall of not less than 4 in. per 100 ft. In deep trenches and in soft or slipping material only bell-end tile should be used, because it retains its alignment better. The tile should be hard-burned and should never be less than 6 in. in size.

After the trenches have been excavated to grade, about 3 in. of cinders should be placed in the bottom to keep out the wet clay. The tile should be laid on the side of the trench farthest from the track, but not less than 4 in. from the side of the trench. The sections of tile should be laid from the low end of the grade or outlet upgrade, the bell ends upgrade. Joints should be left open enough to permit water to enter, but not so open that dirt can enter. The upper end should be closed with a block of wood or slab of stone, and the outlet should be covered with wire netting to prevent animals from getting in.

The backfill should be made of cinders all around and to 12 in. above the pipe. The joints may be lightly covered with hay or straw while the backfill is being made, to keep the joints open. The fill directly over the cinders should be selected material and should be carefully tamped to insure stability of the roadbed. The tile drain is not intended to take care of surface drainage, the ditches providing for this.

If all pockets are not tapped and drained by drains parallel to the tracks, lateral drains should be laid at such intervals as may be necessary. Vegetation with deep roots must never be allowed to grow up over the subdrains.

Electric, Pneumatic and Hand Tamping of Ballast

An electric machine for tamping railway ballast has been tried on the New York Central R.R. It is described by George W. Vaughan, Engineer of Maintenance-of-Way, in a recent bulletin of the American Railway Engineering Association. The tamper is a rebuilt drill of the kind manufactured by the Chicago Electric Tool Co. and was designed by Mr. Vaughan, who about a year ago invented the pneumatic tie tamper sold by the Ingersoll-Rand Co. The electric tamper can now be purchased from the Chicago Electric Tool Co.

The machine weighs about 90 lb., including the tamping bar. It consumes 3.5 amperes at 220 volts, or 0.77 kw., and delivers 1,000 to 1,200 blows per min. The generating plant is mounted on a small push-car and comprises a 2-kw. dynamo coupled to a 4-hp. gasoline engine. This unit weighs about 680 lb. and can supply current for two tampers. The total weight of car and equipment is about 1,900 lb., but this can be reduced considerably.

In a test with regular section gangs a foreman and 6 laborers tamped 1 mi. of track by hand in 26 days at a cost of $11.52 per day, or $299. A foreman and 5 laborers, with electric tamper and supplies, tamped 1 mi. of track in 15 days at a cost of $10.50 per day, or $157, showing a saving of $142. The cost per tie was 9.4c. by hand and 4.9c. by machine.

The same report describes tests with the pneumatic tamper, which has been described in *Engineering News*. This tamper weighs 37 lb., including the bar, and consumes approximately 19 cu.ft. of free air at 70-lb. pressure. The compressor has a capacity of 45 cu.ft. of free air per minute at 80-lb. pressure and is coupled to a 12-hp. gasoline engine. The outfit complete, mounted on a push-car and including two tampers and several hundred feet of ¾-in. hose, weighs about 2,495 lb.

With hand tamping, a foreman and 10 laborers tamped 1 mi. of track in 13½ days at $21.20 per day, or $282. With the pneumatic machine there was a saving of $196 per day. In another test the cost was 6.5c. per tie by hand and 2c. by machine, or a saving of $144 per mi. (3,200 ties). A gang of 40 men ($61.20 per day) tamped 1 mi. of track by hand in 9 days—$550.80. A gang of 21 men ($32.13 per day) tamped 1 mi. by machine in 13 days—$417.69, or a saving of $133.11 per mi. The pneumatic machine tamping was more effective also, the average settlement after 6 mo. being 0.067 ft. for the hand-tamped track and 0.033 ft. for the machine-tamped track.

Electric Track Tamper Used in Germany

Tamping ballast by electric machines was recently tried out in Germany with marked success, according to G. Schimpff, of Aachen, in *Organ für die Fortschritte des Eisenbahnwesens*, December, 1915. The design of the tamper is shown in Fig. 1. Former trials of electric

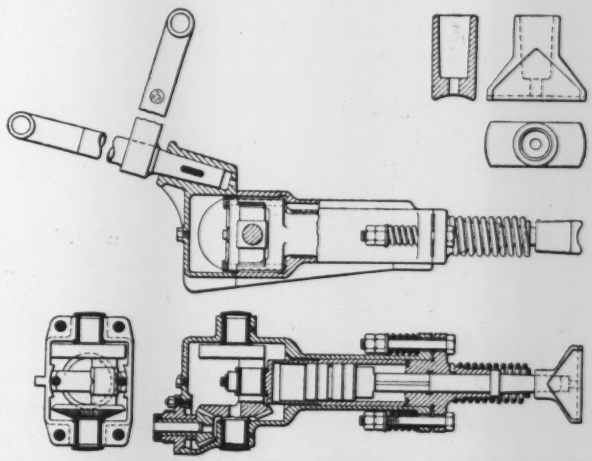


FIG. 1. DESIGN OF ELECTRIC TAMPER RECENTLY USED IN GERMANY

tampers failed to show advantages over hand tamping, chiefly because of the excessive weight and power consumption of the tampers. The present Hampke tamper is brought down to small proportions by using flexible-shaft drive from a stationary power plant and an indirect (air-cushion) action.

FIG. 2.. TWO OF THE ELECTRIC TAMPERS AT WORK ON THE HAMBURG-BERLIN LINE

The gears and crank in the back of the casing, Fig. 1, drive a reciprocating cylinder within which is a free piston thrown back and forth by air compression in the cylinder. This piston strikes the end of the tamper bar socketed in the front of the casing. The machine weighs 53 lb. Its casing diameter is 4½ in. The tamper bar and head weigh 3½ lb.

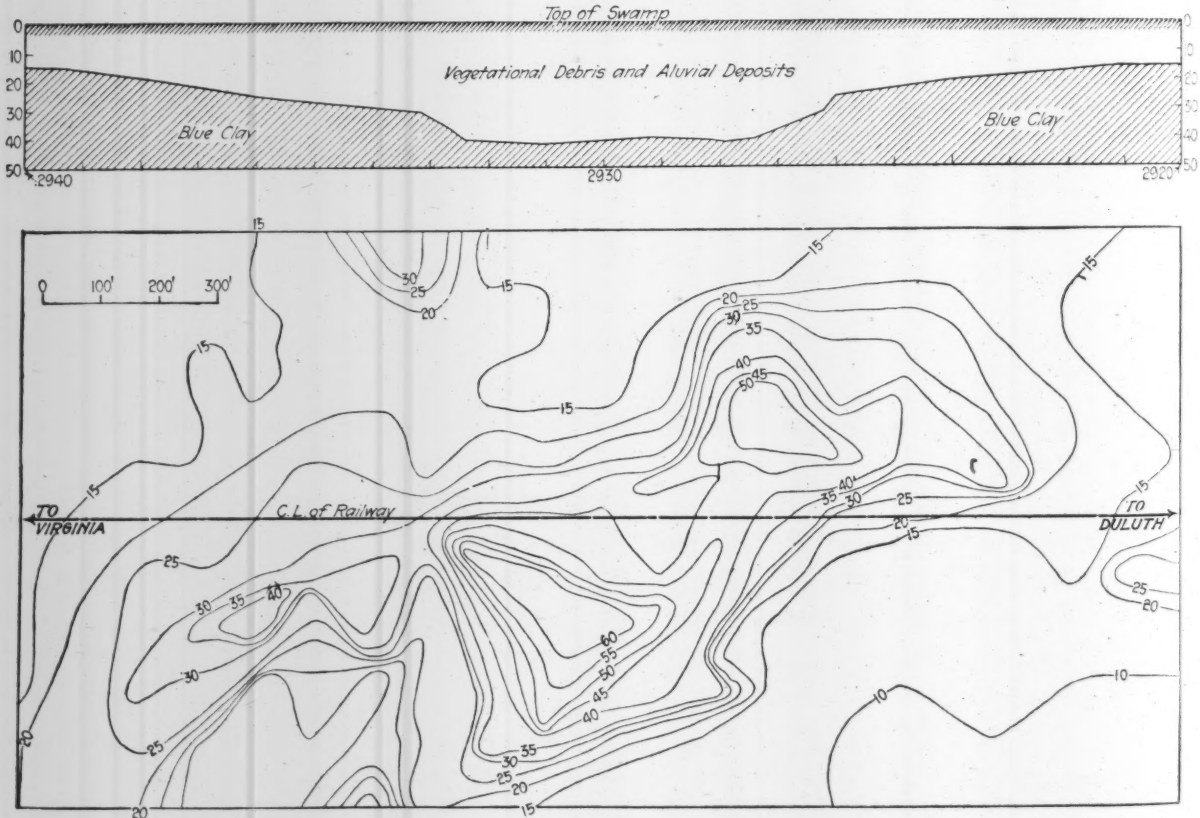
Power is provided by a ¾-hp. motor weighing 46 lb. Where electric current is not readily available, a generator car is used. This is a small truck carrying a direct-current dynamo of 2.3 kw. capacity driven by a 4-hp. benzol engine.

The generator car with distributing cable cost $700 (2,800 M.). The tamper, with motor, cost $245 (980 M.). Fixed charges are computed (at 30% depreciation and 15% interest and maintenance for the tamper, 15%, and 10% for the generator car) as 55c. per day for one tamper and 87c. per day for the generator car. Attendance and fuel for the latter are estimated at about $1.50 per day. Working costs with four tampers (9 men in gang, at 80c. per day) are estimated at $11.16 per day, and the daily output of the gang is taken at 500 ft. of track, making a cost of 2.2c. per foot of track. This is said to be 40% below the cost of hand tamping. With hand work 21 men would be required to do the same amount of work per day.

Four of these machines were used on a 5,354-ft. strip of track on the Hamburg-Berlin line between Friedrichsruh and Schwarzenbek. A gang of six men was employed—four tamping and two leveling and smoothing off the ballast. The work proceeded at the rate of 230 ft. per day and was finished in 23 working days.

Building Railways Across Muskeg Swamps

A muskeg swamp is one composed of decayed moss and vegetation that has gradually filled the irregular depressions of a bed of glacial drift. Between this filling and the drift is usually a bed of impervious blue clay. Some of the depressions are of great size and depth, where masses of glacial ice have been embedded and slowly melted. Under these conditions there is no surface indication of the depth of contour of the hard bottom. These swamps are found in the northern part of the United States and in Canada. Some of the diffi-



SECTION AND CONTOUR MAP OF A MUSKEG SWAMP ON THE DULUTH, WINNIPEG & PACIFIC RY.
The contours are at 5-ft. intervals and show the hard bottom of the swamp

culties of locating and building railways in such country were described at the annual meeting of the Minnesota Surveyors and Engineers Society by J. L. Pickles, Chief Engineer of the Duluth, Winnipeg & Pacific Ry.

In making the location the engineer is apt to take it for granted that the muskeg is shallow and will support the roadbed. There is strong temptation to lay long tangents across the level and open surface of the swamp rather than to adopt a more irregular line in the neighboring higher hard ground, whose roughness is apparent and which is invariably covered with thick vegetation. It is advisable, however, to proceed as in locating over frozen lakes and not trust the moss covering until its bearing value has been tested by soundings. Such tests will often show that the surface is floating, the old pool or depression not being filled to the bottom. Where the depth is less than 15 ft., the swamp will usually carry traffic. The areas void of tree growth should be regarded with suspicion, as this feature usually indicates deep and recent formation and quite often indicates floating bog.

On some railways it has been found that, had adequate soundings been made previous to final location, much money could have been saved over what was necessarily spent to bring the road up to the required standard after operation was begun. An example is shown by the accompanying drawing. As constructed, the line had a heavy corduroy foundation, but this broke through the crust before traffic was started. Soundings after failure showed a depth of about 60 ft. to apparently hard bottom. About 83,000 yd. of material was required to bring the track above water again, and much time and money were lost, which would have been avoided had adequate soundings been taken during the location.

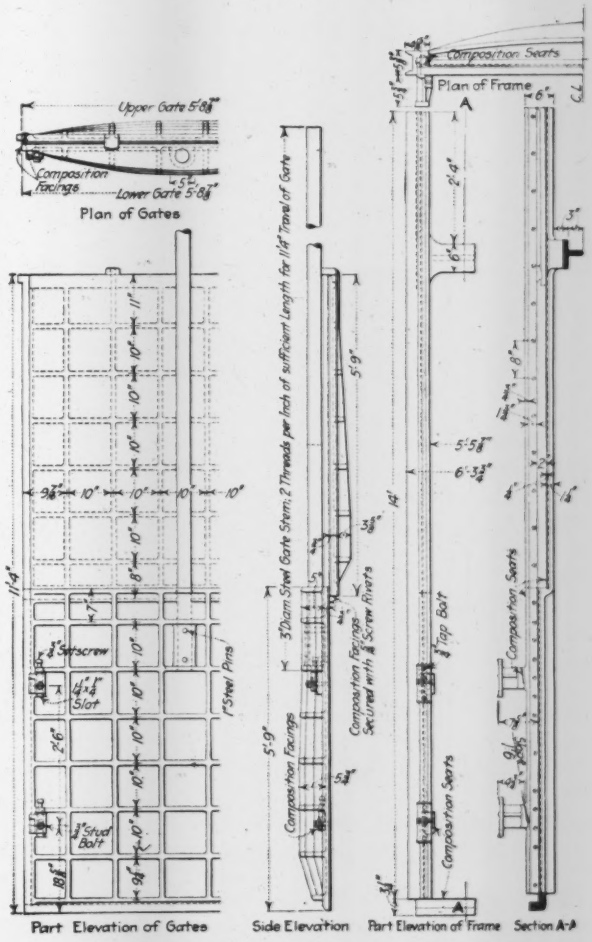
In railway construction over muskeg swamps the methods in general use are as follows: 1. To follow the usual form of construction, laying the track directly on the surface and afterward ballasting up to grade. 2. To corduroy or crossway the surface with long timbers, in alternate layers parallel and transverse to the line, afterward bringing the track to grade with ballast. 3. To excavate ditches along each side and use the material to form an embankment. 4. To use sawdust, cinders or other light material to carry the line, depending on the buoyancy of the muskeg for support. 5. To fill to the bottom with logs and timber. 6. To fill with excavated material. 7. To build a trestle. 8. Where considerable embankment is to be carried over the swamp, piles have been driven about 4 ft. c. to c., capped with timber grillage on which the fill is deposited.

Drainage often gives beneficial results; but where deep muskeg is encountered, such work is often impracticable, owing to lakes in the vicinity and the heavy expense required for the great length of ditches necessary to reach an outlet. Ditches cut in muskeg are apt to close, and it is a constant source of expense to keep them open. While such ditches are of more benefit to the surrounding country than to the railways, they give rise to suits in which the company is usually the loser. Mr. Pickles stated that for this reason many of the swamps in the northern part of Minnesota are not drained.

Whatever form of construction is decided upon, a good foundation must be obtained. Otherwise there will be constant expense and trouble from settlement and rail running (causing broken rails, derailments, etc.), which will result in heavy maintenance charges. In locations over muskeg country it is well to keep the grade as near the surface as good drainage will permit, in order to prevent overloading. Heavy embankments may break through the surface and in some instances will cause rupture through the underlying strata into the substratum, which is of an older formation but not yet solidified sufficiently to carry the increased load.

"Double-Hung" Sluice Gate

In the construction of the new hydro-electric power station at the Sudbury dam in Southboro, Mass., the Metropolitan Water and Sewerage Board is installing three large sluice gates of novel design. The height of the opening is so great that if the sluice gates were made in one piece, they would project above the floor of the



SAVING GATE SPACE IN A POWER PLANT BY USING TWO-LEAF HUNG GATES

gate house when opened. As this was not desirable, designs were made for a gate consisting of two parts like a hung window, but operating somewhat different.

The gate stem is attached to the lower half, which when raised to the point where its top edge or meeting rail reaches the top edge of the upper half engages with lugs on the upper half and carries it along. The gate therefore occupies, when open, practically one-half the vertical space that it covers when closed. Details of design are shown in the accompanying sketch.

Mathematicians and Computers Solve Sphere Problem

A computation problem of unusual difficulty, published in *Engineering News*, Jan. 27, 1915, p. 176, set a large number of readers to work devising a method for solving the problem and making the computation. The problem is to find the volume of the part segment cut out of a sphere of 7-ft. radius by two planes at right angles to each other, such that the widths of the two faces are 3 ft. and 0.963 ft. respectively (see Fig. 1).

Most of the computers adopted the prismoidal formula, without any demonstration of its applicability to the case. Three ways of applying the formula were used by the solvers of the problem, and the results for the three differ, which proves that the formula is approximate and not exact for the sphere segment.

Trying the calculus to get an exact formula for the volume, a hopeless-looking integral is obtained. Nevertheless, four men succeeded in performing the integration and obtained the exact volume formula thereby. They are Prof. H. W. Reddick, Cooper Union, New York City; Prof. James E Boyd, Ohio State University, Columbus; J. M. Sorensen, Chicago, Milwaukee & St. Paul Ry., Chicago, who also gave the derivation in detail; and George Paaswell, New York City.

Exact Volume Formula by Integration

The differential expression can be established for rectangular coördinates with either triple integration or with single integration; and for polar coördinates around the center of the sphere, with triple integration. The various methods lead to substantially similar forms of integral. The simplest process is to use single integration with rectangular coördinates, inasmuch as the area of the circular segment is easly expressed by geometry and algebra.

In Fig. 2 the given quantities are L and H, besides the radius R. From these the distances a and b of the cutting

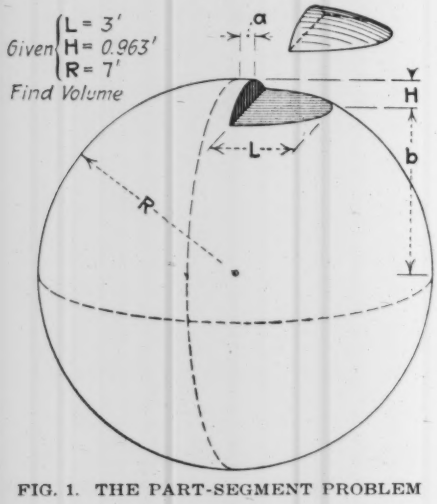


FIG. 1. THE PART-SEGMENT PROBLEM

planes from the parallel median planes of the sphere are readily computed. The elements of the horizontal section of the segment and the formula for the volume are conveniently expressed in terms of a and b instead of in the originally given quantities. Fig. 2 shows a side elevation of the sphere, where any horizontal section of the part segment, at the (variable) height z above the horizontal center plane of the sphere, has radius r and width $r - a$. In plan this horizontal section, Fig. 3, has a half-central angle A equal to $\cos^{-1}\frac{a}{r}$. The area of the sector, equal to half the length of the arc times the radius, is equal to Ar^2, and the area of the triangle that must be subtracted is $a\sqrt{r^2 - a^2}$. But the variable r must be expressed

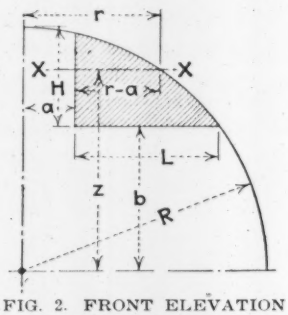


FIG. 2. FRONT ELEVATION OR VERTICAL SECTION

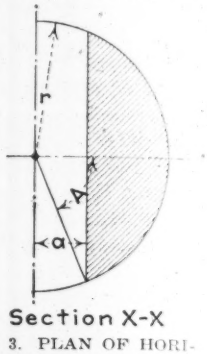


FIG. 3. PLAN OF HORIZONTAL SECTION

in terms of the principal variable z by the relation (see Fig. 2) $r = \sqrt{R^2 - z^2}$. Making the substitution, the formula for the area of the circular segment is

$$S = (R^2 - z^2)\cos^{-1}\frac{a}{\sqrt{R^2 - z^2}} - a\sqrt{R^2 - a^2 - z^2}$$

Using this expression, direct integration on z gives the volume of the segment if the proper limits are used:

$$Volume = \int_b^{\sqrt{R^2 - a^2}} (R^2 - z^2)\cos^{-1}\frac{a}{\sqrt{R^2 - z^2}}\,dz - a\int_b^{\sqrt{R^2 - a^2}} \sqrt{R^2 - a^2 - z^2}\,dz$$

The second integral is a common form that may be found in practically every integral table or can be brought into directly manageable shape by substituting for z the value $\sqrt{R^2 - a^2}\sin u$. The difficulties arise with the first integral. Its integration is as follows:

$$\int (R^2 - z^2)\cos^{-1}\frac{a}{\sqrt{R^2 - z^2}}\,dz = \int \cos^{-1}\frac{a}{\sqrt{R^2 - z^2}}\,d\left(R^2 z - \frac{z^3}{3}\right)$$

Integrating by parts, according to the scheme $\int v\,du = uv - \int u\,dv$, the integral becomes

$$\left(R^2 z - \frac{z^3}{3}\right)\cos^{-1}\frac{a}{\sqrt{R^2 - z^2}} + \int \left(R^2 z - \frac{z^3}{3}\right)\frac{az\,dz}{\sqrt{R^2 - a^2 - z^2}\,(R^2 - z^2)}$$

In the last integral the following simplification is made:

$$\frac{\left(R^2 z - \frac{z^3}{3}\right)z}{R^2 - z^2} = \frac{\frac{z^2}{3}(3R^2 - z^2)}{R^2 - z^2} = \frac{z^2}{3} - \tfrac{2}{3}R^2 + \frac{2R^4}{3(R^2 - z^2)}$$

so that we have

$$\left(R^2 z - \frac{z^3}{3}\right)\cos^{-1}\frac{a}{\sqrt{R^2 - z^2}} + \frac{a}{3}\int \frac{z^2 dz}{\sqrt{R^2 - a^2 - z^2}} - \frac{2aR^2}{3}\int \frac{dz}{\sqrt{R^2 - a^2 - z^2}} + \frac{2aR^4}{3}\int \frac{dz}{(R^2 - z^2)\sqrt{R^2 - a^2 - z^2}}$$

The first two of these integrals simplify easily by the substitution

$$z = \sqrt{R^2 - a^2}\cos u$$

The third integral can by the same substitution be brought into the form $\int \frac{du}{A + B\cos u}$, which is found in most tables, integrating into inverse-tangent form; or it can be found direct in inverse-cosine form in the larger integral tables. The three integrals then are:

$$\frac{a}{3}\int \frac{z^2 dz}{\sqrt{R^2 - a^2 - z^2}} = -\frac{az}{6}\sqrt{R^2 - a^2 - z^2}$$

$$-\frac{a}{6}(R^2 - a^2).\cos^{-1}\frac{z}{\sqrt{R^2 - a^2}}$$

$$\frac{2aR^2}{3}\int \frac{dz}{\sqrt{R^2 - a^2 - z^2}} = -\frac{2aR^2}{3}\cos^{-1}\frac{z}{\sqrt{R^2 - a^2}}$$

$$\frac{2aR^4}{3}\int \frac{dz}{(R^2 - z^2)\sqrt{R^2 - a^2 - z^2}} =$$

$$-\tfrac{2}{3}R^3 \tan^{-1}\frac{R\sqrt{R^2 - a^2 - z^2}}{az} =$$

$$-\tfrac{2}{3}R^3 \cos^{-1}\frac{az}{\sqrt{R^2 - z^2}\sqrt{R^2 - a^2}}$$

Then the complete integral of the two terms that make up the volume becomes, after substituting the limits of integration:

$$Volume = \tfrac{2}{3}ab\sqrt{R^2 - a^2 - b^2}$$

$$+\tfrac{2}{3}R^3 \cos^{-1}\frac{ab}{\sqrt{R^2 - a^2}\sqrt{R^2 - b^2}}$$

$$-\tfrac{1}{3}a(3R^2 - a^2)\cos^{-1}\frac{b}{\sqrt{R^2 - a^2}}$$

$$-\tfrac{1}{3}b(3R^2 - b^2)\cos^{-1}\frac{a}{\sqrt{R^2 - b^2}}$$

It is noticed that the formula is completely symmetrical in a and b, as the geometrical conditions require. Making either a or b equal to zero, the formula reduces to the well-known expression for the volume of a full spherical segment. For example, making b equal zero, the volume of a half-segment is given:

$$Volume = \frac{\pi R^3}{3} - \frac{\pi a}{6}(3R^2 - a^2) = \frac{\pi h^2}{6}(3R - h)$$

which can be derived direct from the volume of the spherical sector and the cone cut off from it by a plane.

Mr. Paaswell gives the integration in a different form. Using the radius of the base circle of the segment, $r = \sqrt{R^2 - b^2}$, his solution is:

$$Volume = \tfrac{2}{3}ab\sqrt{r^2 - a^2} + \frac{\pi}{6}(2R^2(R - b) - br^2) +$$

$$\tfrac{1}{3}b(2R^2 + r^2)\sin^{-1}\frac{a}{r} - \tfrac{1}{3}a(3R^2 - a^2)\tan^{-1}\frac{\sqrt{r^2 - a^2}}{b}$$

$$-\tfrac{2}{3}R^3 \tan^{-1}\frac{ab}{R\sqrt{r^2 - a^2}}$$

This formula, which can be transformed into the other algebraically, is claimed to be better for the present example, because the numerical values of the several terms are lower, the largest being about 36.

Professor Boyd computes by the formula the value 7.46 cu.ft. as the volume of the part segment. Mr. Sorensen, using a larger number of decimal places, obtains 7.4537. Mr. Paaswell gets 7.4044, which he says is probably correct to the third decimal place. Professor Reddick does not give a numerical solution but S. L. Peebles, New York City, computed by his formula the value 7.452. A seven-place computation gives 7.45204 cu.ft.

The accuracy of the computation is affected by the transformations required in computing the three inverse cosine terms, as well as by the fact that the formula is one of differences. The four terms according to Mr. Sorensen's calculation are given in the numerical equation

$$V = 8.2871 + 326.9387 - 312.5767 - 15.1957 = 7.4537$$

Thus the individual terms from which the result is computed are over 40 times as large as the result, and the final volume has nearly two places less of accuracy than the computations up to that point.

Different Applications of Prismoidal Formula

Application of the familiar prismoidal formula is subject to the uncertainty of how truly this formula applies to the segment of a sphere or part of such a segment. By comparing the result of the prismoidal-formula calculation with the result from the integrated formula the correctness of the prismoidal formula for this case can be judged.

The prismoidal formula can be applied with either face of the part segment as a base, or it can be applied to that part of the half-segment which is cut away (lying between the inner face of the segment and the median plane of the sphere). In the latter case, of course, the volume of the complete segment is computed by the geometrical formula

$$V = \frac{\pi h^2}{3}(3R - h)$$

With the 3-ft. face of the segment as base, computations were made by Frank S. Bailey, East Braintree, Mass., who obtained 7.5106 cu.ft.; S. Arkin, New York City, 7.51, and S. L. Peebles, New York City, 7.510. A check confirms all these to the third place.

With the 0.963-ft. face of the segment as base, S. Arkin obtained 7.47, and S. L. Peebles 7.568. A check with seven-place work gives 7.56734. As might be expected, the error of this calculation is greater than that of the preceding, as the body is higher and has more curvature.

The subtractive prismoidal method, computing the volume of the half-segment and deducting the small piece adjoining the median plane of the sphere, was adopted by a number, but several of these were content to use the average-end-area method for getting the volume of the small subtractive piece.

The advantage of the subtractive computation is that the influence of the approximation is minimized. On the other hand, there is more detail computation, as three circular segments have to be computed.

Typical results with prismoidal subtraction are: Edward Godfrey, Pittsburgh, Penn., 7.478 with three-place work; E. J. Creighton, Denver, Colo., 7.54 (with some approximations to shorten the computation of the circular segments); seven-place check computation, 7.4525.

A slight variation, to save labor, was employed by E. A. Batley, Rome, N. Y., and S. Arkin, New York City, who found first the volume of the full spherical segment and then deducted the central part symmetrical about the vertical median plane of the sphere, computing the vol-

ume of this subtractive portion by the prismoidal formula. Their results are 7.482 and 7.495 cu.ft.

Average-end-area subtraction gave the following results, among others: Prof. James E. Boyd, Columbus, Ohio, 7.46; E. E. Halmos, New York City, 7.51; Charles W. Chassaing, East St. Louis, Ill., 7.52; A. Yappen, Chicago, 7.717.

An interesting misinterpretation of the problem was made by one correspondent, who took it to call for the volume of the torus whose ring-section is the circular part segment of base 3 ft. and height 0.963 ft., the axis of revolution being parallel to the 0.963-ft. face.

Further Results; Area of Surface; Volume of Three-Plane Segment

Prof. H. W. Reddick, New York City, whose integration of the volume has been mentioned, also integrated the curved surface of the part segment. He gives the formula:

$$S = 2R\left(R\cos^{-1}\frac{ab}{\sqrt{R^2-a^2}\sqrt{R^2-b^2}} - b\cos^{-1}\frac{a}{\sqrt{R^2-b^2}} - a\cos^{-1}\frac{b}{\sqrt{R^2-a^2}}\right)$$

The scope of the integration has been extended by Mr. Sorensen to the case of a segment bounded by three planes

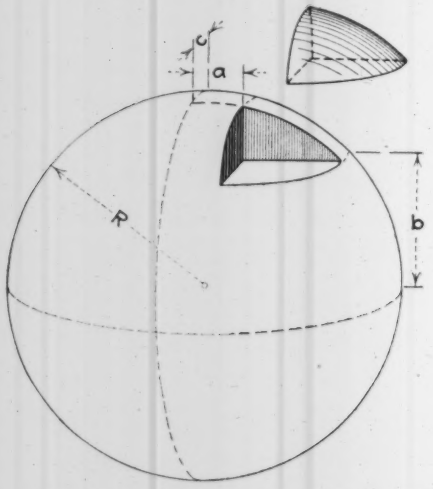


FIG. 4. GENERAL CASE; THREE CUTTING PLANES AT RIGHT ANGLES

at right angles, Fig. 4. The solution, obtained by methods similar to those used in the previous case, is:

$$\text{Volume} = \frac{ab}{3}\sqrt{R^2-a^2-b^2} + \frac{bc}{3}\sqrt{R^2-b^2-c^2} + \frac{ac}{3}\sqrt{R^2-a^2-c^2} - abc$$

$$-\frac{a}{6}(3R^2-a^2)\cos^{-1}\frac{c\sqrt{R^2-a^2-b^2}+b\sqrt{R^2-a^2-c^2}}{R^2-a^2}$$

$$-\frac{b}{6}(3R^2-b^2)\cos^{-1}\frac{a\sqrt{R^2-b^2-c^2}+c\sqrt{R^2-a^2-b^2}}{R^2-b^2}$$

$$-\frac{c}{6}(3R^2-c^2)\cos^{-1}\frac{a\sqrt{R^2-b^2-c^2}+b\sqrt{R^2-a^2-c^2}}{R^2-c^2}$$

$$+\tfrac{1}{3}R^3\left(\cos^{-1}\frac{ab}{\sqrt{R^2-a^2}\sqrt{R^2-b^2}}+\cos^{-1}\frac{bc}{\sqrt{R^2-b^2}\sqrt{R^2-c^2}} + \cos^{-1}\frac{ac}{\sqrt{R^2-a^2}\sqrt{R^2-c^2}}\right)$$

Here, as in the previous example, the distances of the three cutting planes from the center of the sphere, a, b and c, are to be computed from the given quantities. If the three lengths of the segment are given, L, M and N, three formulas can be written:

$$(a+L)^2 + b^2 + c^2 = R^2$$
$$a^2 + (b+M)^2 + c^2 = R^2$$
$$a^2 + b^2 + (c+N)^2 = R^2$$

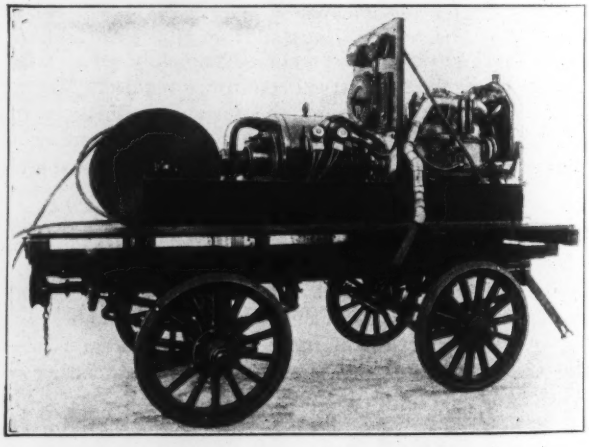
which are solved as numerical equations.

The labor involved in all the analyses and calculations connected with this problem is very considerable. The voluntary coöperation of so many able computers in working out the problem is worthy of special commendation.

NOTES

Rapid Rail Renewal with Locomotive Cranes is reported by the Lehigh Valley R.R. On 4.07 mi. of track between Gilbert and Lodi, N. Y., the track was relaid with 100-lb. rails in about 6 hr. and the track entirely completed and the old rails picked up and loaded on cars 6 hr. later. This work was done by four cranes without interrupting traffic. The railroad uses this equipment extensively in trackwork. It owns about 30 locomotive cranes and has purchased 6 more.

St. Paul's Electric Pipe-Thawing Machine—In St. Paul, Minn., an electric pipe-thawing outfit has just been put in service by the municipal water department. It was built from specifications drawn by G. O. House, General Superintendent and Engineer. In such a climate as St. Paul's, where frost goes down 5 ft. and at times 7 ft., frozen water pipes, especially house connections, are not unusual. When the thawing out was dependent on digging down to the frozen pipe, annoying and often serious delays followed. This machine consists essentially of a four-cylinder 1,000-r.p.m. automobile engine driving a 20-kw. direct-current 40-volt generator, a field rheostat (for regulating voltage from 0 to 40), 500 ft. of insulated 300,000-cm. copper cable in 100-ft. lengths, a reel, etc., all mounted on a 1½-ton trailer truck with solid rubber tires. To thaw out a main, the necessary



ST. PAUL'S ELECTRIC THAWING TRUCK

lengths of cable are reeled off and run from the generator to convenient connections of the frozen pipe, and the engine is started. The machine has been practically tested during a recent low-temperature period with remarkable results, 4 to 5 min. sufficing to clear a frozen pipe that would probably have taken one or two days, if dug for. The machine was built for city use, but may be hired by plumbers at a reasonable rental. It is estimated that the machine will pay for itself in two years by direct saving in money plus the indirect saving from time once expended in digging. The unit cost $2,700 ($700 for the truck and $2,000 for the equipment set up). The engine was made by the Capital Engine Works, St. Paul; the generator by Roth Brothers, Chicago; and the tractor by the Troy Wagon Works, Troy, Ohio. The machine was assembled by E. L. Sudheimer, St. Paul.

Editorials

Air and Electric Track Tampers Are Both Successful

Tamping railway ties, until the summer of 1913, was done wholly by human muscle. About that time a pneumatic tie tamper appeared upon the market. That this machine is successful is evidenced by its rapid introduction on both steam and electric railways. At the present time the New York Central R.R. owns pneumatic-tamping equipment to the value of $75,000; and the machines are in use on the Lehigh Valley, the Pennsylvania, Hudson & Manhattan, Erie, Delaware, Lackawanna & Western R.R. and other railways.

Two years ago G. W. Vaughan, Engineer of Maintenance-of-Way of the New York Central lines—the inventor of the pneumatic tamping machine, began experimenting with an electric tamping device of his own design. In the midst of his experiments a derailment destroyed the machine; but a new one was constructed, which has worked satisfactorily and is now on the market. Another electric tamper, of quite different design from Mr. Vaughan's, has recently been developed in Germany. Both machines are described in this issue.

Now that a start has been made in the commercial use of power tamping machines, there is reason to believe that their employment will be extended very rapidly. For some years past there has been increasing difficulty in securing men for track-maintenance work, and this difficulty is rapidly growing acute. Merely by the operation of the law of supply and demand the railways are going to be compelled to pay higher wages to trackmen. Reliance on breaking in new men to the work from recently arrived immigrants fails when the tide of immigration is cut off.

The use of machines which enable a man to accomplish more work and which require less muscle will make it possible to hold men who otherwise would quit for some less laborious occupation. The surprising thing is that man power—the most costly form of power—should have so long continued to be the exclusive reliance for the hard work of tamping ties.

Hardness Tests for Bronzes

Hardness tests have been used far less in this country than they deserve. The specification of the Brinell test for bronzes by the New York Central Railroad Co. is interesting in this respect. It is even more interesting because a compression test is coupled with the Brinell test, and some metals are judged mainly by the first, while others are judged by the second test.

Both tests are measures of hardness, in a way. For heavy service chief dependence seems to be placed on compressive strength and the ability of the material to stand a certain degree of squeezing out of shape without cracking. By specifying certain values for these two qualities a measure of plasticity is obtained in conjunction with a measure of hardness. Evidently, the object is to get an indication of load-carrying ability and of anti-friction qualities. The Brinell test, giving only one figure instead of two, supplies no information on plasticity.

Of the relation between this type of compression test and the hardness test little is known. Probably the relation is not the same for a material of distinctly composite structure, as a bronze, that it is for a more nearly homogeneous material, as steel. On this question, however, it is likely that students of micrography will have pronounced individual opinions.

South Orange Grade Elevation a Notable Construction

Even without the authority of statistics it is probably safe to say that the amount of money being expended by the railways of the country on grade-crossing elimination far surpasses all sums being spent on other railway construction. The demand for safe crossings is being successfully enforced by not only the large cities, but by the smaller towns and villages, while at the same time the dictates of economy force the railway to the high first cost of crossing elimination to offset the continual expense of watchmen at crossings and the occasional, but inevitable, damage suit. Necessarily the increase in this work has brought about a development in the type of structure used, and the old plate-girder street crossings almost universal a decade ago are being superseded by bridges which, while possibly not more economical, are certainly much more pleasing to the eye and which give promise of longer life.

Of these newer types none is more novel or more artistic than the recently completed South Orange overhead crossing of the Lackawanna R.R., described on another page of this issue. Girderless slabs of reinforced concrete are not new for railway work—the Soo Line freight station at Chicago is now over two years old—but the use is sufficiently rare to call for comment. In this particular case only a thorough analysis could show whether the design is the most economical that could have been used, although the required variation of span length and skew are undoubtedly taken care of much more readily with the flat-slab design than with any other available; but there is no doubt that the long spans and flat ceiling lend themselves admirably to the artistic development of a structure into the embellishment of which was put so much effort. This embellishment, which consists not only of discreet ornamentation, but also of a bush-hammered surface of superior quality, no doubt lends much to the appearance of the structure. It would be well worth the while of the railroad to conduct free excursions to the South Orange crossing for the benefit of those citizens of the lower Oranges who have for so long stood out for track depression through their cities.

In the great amount of reconstruction the Lackawanna has been carrying out in the suburban zone outside of New York it has been the consistent policy of the road

to lay great stress on the appearance of the stations. In this respect the South Orange work is fully up to the previous high standards. The utilization of the inter-column space beneath the track floor for carriage and motor stands, sidewalks and station accommodations has made a virtue rather than a detriment of the track elevation and has permitted a most satisfactory architectural solution of the station-building problem.

The Pennsylvania Investigation of Licensing Engineers

Three years ago the Pennsylvania legislature passed an act creating a commission of five engineers, "to investigate the advisability of licensing engineers who are engaged upon the construction, maintenance and operation of work, public and private, where unusual hazards exist."

The commission appointed by the governor to carry out this task was made up of F. Herbert Snow, chairman, John Price Jackson, secretary, and Samuel A. Taylor, George S. Webster and J. Murray Africa. Some conclusions of this commission were printed on page 484 of our last week's issue. The complete report of the commission is soon to be printed and made available to the public and presents for the first time a complete discussion of the proposal to regulate the practice of engineering by state laws, with the arguments for and against it.

For more than a dozen years the subject of state legislation to regulate the practice of engineering has been discussed by engineers, and laws providing a limited amount of such regulation have been enacted in several states. The subject is one on which opinions in the profession differ radically. Speaking broadly, it is probably the case that the bulk of engineers who have achieved success are opposed to state regulation. On the other hand, there are many, especially of the younger men, who have come to believe that many of the difficulties and disadvantages under which the profession labors can be removed by proper legislation and that such legislation would operate to improve the condition of a large proportion of engineers.

As to what form such regulation should take, ideas in general have been extremely hazy. Very few engineers anywhere have really given such systematic thought and study to this subject as they would give to a technical problem in engineering. The whole engineering profession, therefore, owes a debt to the State of Pennsylvania and particularly to the five eminent engineers who have carried out this investigation and whose official report will henceforth be the textbook of those who care to investigate seriously the state regulation of engineering practice.

Their report, of which 4,000 copies are to be printed for free distribution, ought to be placed in the reference library of every engineering society, every engineering school and in the legislative reference library at every state capital. Many engineers in private practice, also, we doubt not, who have taken an active interest in this subject will wish to secure a copy of the book.

It may be of interest at this point to summarize a little hitherto unwritten history concerning the agitation for state licensing of engineers. After the agitation in Canada some 15 years ago, when it was attempted to give members of the Canadian Society of Civil Engineers the sole right to practice engineering in the Dominion, little was heard of laws to regulate engineering practice until an organization in New York City, known as the Technical League, took up the idea and introduced bills in the New York legislature to carry its plans into effect. For several years in succession bills of this sort were introduced, and delegations of well-known engineers went to Albany to oppose them, succeeding in each case in having them killed in the committee. None was ever reported to the legislature. It became evident, however, that there was a considerable element of the profession which favored such legislation, and the number included some eminent members.

On the plea that if such legislation was at any time to be forced upon the profession, engineers themselves should plan the form which it should take, a joint committee was organized, made up of representatives of five of the national engineering societies, under the chairmanship of the late Alfred Noble, for the purpose of drafting such a model bill.

This committee, it should be said, was far from unanimous in its opinion concerning such legislation. It took as a basis, however, a bill that had previously been drafted by a committee of the American Society of Civil Engineers and which was of the most sweeping character, requiring engineers engaged in any class of engineering work whatever, except military engineering, and whether in private or in public work, to pass examinations and take out licenses in order to practice their profession. This committee, after several meetings, finally reached a deadlock in its deliberations and adjourned. The bill that it had nearly completed has never been reported to or approved by the governing board of any of the national societies that were represented on the committee.

Copies of this bill, however, reached the members of the State Engineering Commission of Pennsylvania and were used by that commission as the basis of a draft of a bill that it prepared for the purpose of arousing public interest and discussion among the engineers of Pennsylvania on the general subject of state regulation of the engineering profession. The commission held public hearings in the fall of 1914 at Pittsburgh, Philadelphia and Harrisburg, which were well attended by prominent engineers. The bill was also taken up for discussion by the Association of Philadelphia Members of the American Society of Civil Engineers, by the Engineers' Club of Philadelphia, by the Philadelphia Section of the American Institute of Electrical Engineers, by the Engineers' Society of Western Pennsylvania and by the Engineers' Society of Pennsylvania.

From the discussion at these public hearings and before these engineering societies, which is presented in full in this report, it is apparent that the proposal that all engineers should be licensed and examined by state authority meets the well-nigh unanimous condemnation of the engineering profession. On the other hand, it is equally evident that there are many unsatisfactory conditions in the practice of engineering as at present carried on, which the profession itself has thus far been unable to remedy and which seems to require some sort of state legislation for the protection of the public and of reputable members of the profession.

In the summary of the commission's conclusions, printed in our last issue, a plan is recommended under which engineers engaged in public service, whether of cities, states or counties, would have their qualifications

tested. Engineers engaged in subordinate positions would have to pass civil-service examinations. Engineers who are candidates for higher positions would be judged on their past professional record, just as they would be were they to enter the service of a private firm or corporation. Engineers engaged in general practice, who do work for cities on a fee basis, would be required to file with some public authority a sworn statement of their professional record, giving testimonials, etc. The authorities of a city or town desiring to engage an engineer, therefore, could by reference to these state records ascertain what the men who had applied for the work or others whom it might wish to engage had done in the past. The board with which such certificates of professional record were filed would have authority to cancel such registration for cause, such as fraudulent representation.

A perusal of the commission's report makes it evident that the members of the commission were much more favorably disposed to, and inclined to go much farther in, state regulation than were most of the prominent engineers who appeared before the commission at its hearings. An explanation for this may be found probably in the fact that Mr. Snow, the chairman of the commission, in his work as chief engineer of the Pennsylvania Department of Health has to examine and pass upon the plans for certain municipal works submitted by engineers employed by cities in Pennsylvania. He is familiar, as few engineers are, with the extent to which smaller municipalities often suffer from the employment of incompetent engineers.

At the present time there appears to be a decided lull in the agitation for state licensing of engineers. For two years in succession now, nothing has been heard of the subject in the New York legislature; and with the multitude of other more important subjects pressing upon public attention, there seems little likelihood of legislation of this sort going forward unless engineers themselves organize and work to secure it.

Wherever and whenever such legislation is proposed, however, the profession is fortunate henceforth in having the Pennsylvania report at hand as a textbook to indicate what not to do, as well as the directions from which some benefit to the public and the profession may be expected.

Garbage Reduction Encouraged

The reactions of the European War show themselves with unexpected force in unsuspected places. For instance, a year ago it was predicted that the price of garbage grease would slump because of war conditions. Instead, it has reached the remarkably high figure of 6.26c. per lb. at Cleveland, owing to the heavy demand for grease for glycerin and red oil for dyestuffs. It is reasonable to suppose that garbage tankage prices would also rise with the curtailment of nitrate and phosphate supplies. Of course, war prices afford narrow and unstable foundations for permanent investments; but the after-war readjustments in the field of the products named are likely to take so long as to warrant garbage-reduction works to enlarge and perfect their equipment with no loss of time, in order to reap the benefit of present high prices and build up reserves for lean years, if they come.

To what extent the high prices should encourage the establishment of new garbage-reduction plants is a matter for careful consideration in connection with a variety of local conditions that should be given careful engineering study in each case. Certainly, if there was ever a time when garbage-reduction could hold its own against incineration, it is in this year of 1916. Doubtless the proprietors of processes and manufacturers of apparatus for garbage-reduction works are already sitting up and taking notice.

War and Water Purification

The high price of most of the chemicals used in water purification, reviewed elsewhere in this issue, is a serious matter, but far less serious than it would be if liquid chlorine were not available. That agent was already displacing hypochlorite of lime before the war prices came on. Its price has gone up, but the advance is nothing like that for hypochlorite. Fortunately, the unit cost of disinfection by either agent is still so low as to be insignificant when compared with the safety that is insured by its use.

As matters stand, the heaviest burden that war prices place on water-works plants comes through the increase of three or four times in the price of sulphate of alumina, which is widely used as a coagulant and is a considerable item in water-works expenses even under normal conditions. Luckily, water-works superintendents can get along with less of this agent now than before chlorine disinfection came into use.

Since lime has not advanced in price and sulphate of iron is not much more costly than before, the water-works using these materials or which perchance can turn to them are in a fortunate position.

All who are called upon to exercise control over the efficiency of water-purification plants that use any of the high-priced chemicals should be constantly on the alert in these days lest the desire to keep expenses from rising should get the better of the determination to supply safe water at any cost.

A word of caution may well be offered to those who are concerned with sewage-treatment plants employing chlorine disinfection. It is hard enough at best to maintain the use of enough hyprchlorite or liquid chlorine to be of much real service in sewage disinfection. Under existing prices, particularly where hypochlorite is used, skimping, or even cutting out disinfection entirely, may be expected by all except the most conscientious superintendents and the best-financed plants.

Finally, there is much in the present situation to make stronger than ever before the already forcible argument for substituting liquid chlorine for hypochlorite in both water purification and sewage treatment.

Merchants Turn City Planners

A stir was caused in New York City a few days ago by page advertisements in the newspapers, in which leading merchants pleaded for the exclusion of clothing manufactories from the district bounded by 33rd and 59th St. on the north and south and Third and Seventh Ave. on the east and west. The plea is all the more interesting and significant because it comes at a time when a branch of the city government, acting under state legislation of 1914, is engaged in dividing the whole of Greater New York into residence, business and manu-

facturing districts. Such a task is necessarily slow, since it involves the preparation of tentative plans for districting or zoning the city, followed by full opportunity for an expression of public opinion. Conceivably, its execution might be contested, in which case the almost certain ultimate sanction of the highest courts might yet cause long delay.

Compared with all this probable delay, the action of the dozen big merchants, backed by various other powerful interests, seems speedy and efficient, because it sets Feb. 1, 1917, as the date on which these big merchants will begin giving preferences in their purchases to goods manufactured outside the delimited area.

This movement is essentially an appeal from the pocket-book to the pocket-book. It is founded on the sound thesis of preventing another blighted district in New York, with its enormous losses in property values, such as has been created time and again by the northward movement of many classes of business in New York City. Some of these migrations have done no harm except to leave a deserted and blighted district behind them, but the one now in question is believed to cast a blight wherever it extends.

It is certainly time to stop these haphazard movements and try to substitute orderly city development in their place. Where it can be done by coöperation rather than by coercion the results may be more quickly attained, but as a rule the larger interests at stake require both comprehensive and constant supervision and control throughout the whole city by a properly constituted branch of the city government.

An Engineer Returns

An engineer has come into, or partly into, his own again at Seattle. For years R. H. Thomson was not only city engineer, but in large measure he was the administrative government of the city, and that during its most remarkable period of growth. Then malign influences set themselves against him and led him to resign. From that time to this the city council has followed its own notions of city engineering to a marked degree, with some deplorable results. On March 7 Mr. Thomson was elected to the city council, standing next to the highest among the six candidates to fill the three vacancies in Seattle's council of nine members. Undoubedly, Mr. Thomson's great ability and strong personality will again make themselves felt in the city's affairs.

Letters to the Editor

Horizontal Resistance of Piles Under Retaining Walls

Sir—In the ordinary design of a retaining wall founded on piles the number and spacing of the piles to resist the vertical loads imposed are matters of routine design readily comprehended and easily executed. The lateral resistance of the piles to the horizontal thrust of the earth transmitted through the retaining wall is, however, not so well understood.

If a wall is founded on rock, the resistance to sliding is determined by multiplying the vertical component of the resultant by the probable coefficient of friction between the masonry of the wall and the rock foundation. In case this resistance is not sufficiently larger than the horizontal component of the resultant, a suitable key is provided under the foundation, extending into the rock. But for a wall on a pile foundation the piles must furnish the necessary horizontal resistance to sliding, with a suitable factor of safety. For a wall or foundation of which the tangent of the resultant pressure is fairly large the number and spacing of the piles may depend on their resistance to displacement laterally rather than their vertical bearing power.

The required horizontal resistance in each pile just to resist lateral motion might be obtained by dividing the net horizontal force by the number of piles, but the questions now arise: Is this horizontal force resisted equally by each pile, and how much is a pile good for in resisting lateral pressure?

The writer has consulted engineers of wide experience and has explored textbooks, but has been unable to obtain any satisfactory theory or data from tests on the horizontal resistance of piling or the probable distribution of loads. Tests made on piles of different lengths and driven in a variety of soils would probably furnish the most reliable data on horizontal resistance.

CARLTON N. CONNER,
United States Junior Engineer.
Custom House, Cincinnati, Ohio, Feb. 18, 1916.

What Is Invention?

Sir—In connection with your recent editorials and articles on reinforced-concrete patents the following extract, from an address by the late Prof. J. B. Johnson, one-time dean of the engineering school of the University of Wisconsin, will doubtless be of interest:

> Profitable invention must include the use or embodiment of scientific principles with which the untrained artisan is unacquainted. Already our Patent Office is much puzzled to distinguish between engineering and invention. Since engineering proper consists in the solution of new problems in the material world, and invention is likewise the discovery of new ways of doing things, they cover the same field. But an invention is patentable, while an engineering solution is not. Invention is supposed in law to be an inborn faculty by which new truth is conceived by no definable way of approach. If it had not been reached by this particular individual, it is assumed that it might never have been known. An engineering solution is supposed, and rightly, to have been reached by logical processes through known laws of matter and force and motion, so that another engineer, given the same problem, would probably have reached the same or an equivalent result. And this is not patentable. Already a very large proportion of the patents could be nullified on this ground, if the attorneys only knew enough to make their case.

Professor Johnson's address is published *in extenso* in "Addresses to Engineering Students," edited by Waddell & Harrington, pages 25-35. F. H. FRANKLAND.
Lake Charles, La., Feb. 22, 1916.

Snow-Removal Conference Held in New York

Snow-removal methods in cities of from 200,000 up were described and discussed at a conference held in New York City on the evening of Mar. 8, under the joint auspices of the National Highways Association, Society of Street Cleaning and Refuse Disposal of the United States and Canada, Automobile Club of America, Citizens Street Traffic Committee of Greater New York, and the Graduate Course in Highway Engineering at Columbia University. George W. Tillson, who presided, said aptly that if Arthur H. Blanchard picked that date with foreknowledge of weather conditions he deserved to be made chief of the Weather Bureau straightway. Snowstorms occurred both on Feb. 7 and on Feb. 8, and the snow fighters of the Eastern cities were hard at work while their bosses congregated in the Automobile Club of America and explained what the men were doing and how hard it was to get men to work at night.

Seven 30-min. papers were presented, each followed by a short open discussion, the conference closing at 12:30. The following were the speakers: William H. Connell, Chief, Bureau of Highways and Street Cleaning, Philadelphia; John T. Fetherston, Commissioner of Street Cleaning, New York City; George H. Pride, Treasurer, Motor Truck Club; Gus H. Hanna, Cleveland; Leon F. Peck, Superintendent of Streets, Hartford, Conn.; A. E. Kalbach, Deputy Street Cleaning Commissioner, Borough of the Bronx, New York City. The full proceedings of the conference will be published by the National Highways Association.

Until 1912 the removal of snow was not dignified by being regarded as an engineering operation. The old method—and one that still prevails in many centers, especially where money is valuable—was to wait until the snow had ceased falling before inaugurating the counter-attack. Under the present efficient schedule employed by cities of the first class, preparations start with the earliest warning of the approach of a storm, and mobilization of the snow-removal forces commences coincidently with the first flakes.

There are two great classes of removal methods: (1) Those systems and machines that have stood the test of practice; (2) the schemes and devices suggested and offered by inventors. Under the first may be mentioned plowing, loading on trucks and flushing into sewers, and under the second classification occur the various melting devices such as compression boxes, electric grids, asphalt burners and steam pipes (necessitating central-station plants).

The last-named scheme might be theoretically applicable to streets carrying extremely heavy traffic, where the snow must be removed at all costs; but there are two very formidable drawbacks to the use of melting pipes. Maintaining a temperature of 80° on these pipes when the temperature of the surrounding air is zero will certainly cost a lot of money; secondly, only under extremely favorable conditions—and one wonders in what busy streets they are to be found—could the piping be laid beneath the pavement, on account of existing subsurface structures. It is estimated that, in addition to one or more longitudinal mains, laterals would have to be provided every 4 ft. Such a system, were it feasible, would certainly solve the snow-disposal problem in heavy-traffic streets, and some time—maybe in 50 or 100 years—city planners will no doubt provide the necessary piping in the ideal cities of that era.

An interesting special method was described by Mr. Connell. In the Pennsylvania R.R. terminal in Philadelphia the snow is thrown on a car underframe equipped with a number of longitudinal steam pipes. The melted snow falls through into a pan provided with an overflow outlet. This car can be loaded 25 times before the water has to be dumped. Of course this method has limited application in general city work.

The city presenting the hugest snow-removal problem, naturally, is New York, with its 30,000,000 sq.yd. of street surface to be cleared. It is the aim here to employ 18,000 men per shift, with 84 motor plows and 12 tractors, as against a total force of 4,000 men in Philadelphia. New York's snow-removal force is arranged in four divisions: (1) The snow fighting, consisting of employees of the street-cleaning department, with the plows; (2) the snow removal, comprising the contractors; (3) the first reserve, comprising the garbage-collection force with carts; (4) the second reserve, or volunteer organization, comprising the forces and equipment supplied by public-spirited citizens. The first drive is always directed against the snow on congested thoroughfares.

The main problem in snow removal seems to be that of securing and handling labor. Being human, the men do not like to work at night, during a severe storm or in very cold weather. The answer to this is higher pay. At present New York pays its emergency snow fighters 30c. an hour, as against 25c. in normal times (during the general clean-up after the emergency is passed). The additional 5c. an hour is not dazzling enough to tempt a sufficient number of men to endure the hardships entailed by emergency work. In an endeavor to offset this condition a bonus is paid whereby, if a section gang performs its allotted work in a given time, the men are paid 40c. per hour. Deputy Street Cleaning Commissioner Kalbach, of the Bronx, stated that under the present allotment of work it is almost impossible for the men to earn a bonus. This is a condition that calls either for higher emergency wages or for smaller allotments or, perhaps, for both. Against this argument, however, we have Commissioner Fetherston's statement that the cost of snow removal is getting to be too large in New York City. It passed the million-dollar mark this year.

A system deserving of special mention is the use of sewers for snow disposal. This practice is growing in favor wherever it is permitted. In New York where this method has had a thorough tryout, the cost is 3.1c. per cubic yard (exclusive of cost of water), as against 53.3 for contract work during the six winters preceding the inauguration of the sewer flushing (1914-1915), 36.7c. having been the minimum price paid for contract work. The cost in the winter of 1914-1915, for the sewer and contract work in combination, was 12.1c. per cu.yd., and the cost is running along about the same this year.

On Apr. 17, 1914, a snow-removal conference was held in Philadelphia. At that time it was found that nearly every city had its own problem, the modifiers being traffic congestion, adequacy and availablity of sewers, other means of disposal, population, width of streets, and last but not to be neglected, the financial policy of the municipality. In the past two years much has been learned, as the interesting and profitable 1916 meeting proved.

Flat Slab Used at Lackawanna South Orange Crossing

SYNOPSIS—Grade-elevation work utilizing reinforced-concrete girderless-slab construction. Unique solution of station problem. Slabs designed for heaviest train loading. Detailed methods of construction.

The Delaware, Lackawanna & Western R.R. has just completed through South Orange, N. J., a stretch of about a mile of grade changes to eliminate four grade crossings, which involved the construction of 5,000 ft. of earth-fill, three concrete-bridge street crossings and two stations—one at Mountain Station and the other at South Orange. The former is about at the original grade, and the street crossing is carried over the track on a concrete arch bridge. The latter station is novel in that it is built under and around a reinforced-concrete girderless floor bridge that spans the main street of the town and extends for some 400 ft. beyond the street, to accommodate the station structure. It is approached from each end by a new earth-fill.

South Orange is on the Morris & Essex division, one of the most heavily traveled suburban lines outside of New York. It has had, up to the present, only two tracks through the village. Increased traffic demanded an express track, so reconstruction was projected about two years ago, involving the enlarging of the right-of-way to accommodate three tracks, the middle one of which is used for inbound express traffic in the morning and for outbound express traffic in the evening. At the same time the grade crossings in the village had to be eliminated. It was decided to do this by elevating the tracks, carrying them on an earth-fill with concrete bridge overcrossings at the streets.

At South Orange station, however, which is immediately alongside the main cross-street of the village, property was so valuable that the purchase of extensive right-of-way had to be reduced to a minimum. For this reason it was decided to incorporate the station with the grade-elevation work, so as to reduce the required ground purchase to the smallest possible. Accordingly, a girderless-slab reinforced-concrete bridge was built, extending, as shown in Fig. 2, from the east side of the transverse street 426 ft. west, including under it the sidewalks and pavement of South Orange Ave., which is a county highway, and the sidewalk approaches to the station, the platforms, motor stands, a heating plant and the station proper.

FIG. 1. THE SOUTH ORANGE TRACK ELEVATION AND STATION OF THE LACKAWANNA RAILROAD

The railroad had experience with this type of construction in the viaduct 150 ft. wide and 1,000 ft. long approaching the new Lackawanna terminal improvements now under construction at Buffalo. It was adopted at South Orange for its cheapness, the effective architectural treatment it permits, the very shallow floor depth, the absence of vertical projections above the track and the rigidity of the construction. It is stated that two heavy locomotives passing over the structure at high speed produce hardly any vibration and that the rumbling noises common on structural-steel bridges are very much subdued, thus avoiding the usual street-crossing nuisance.

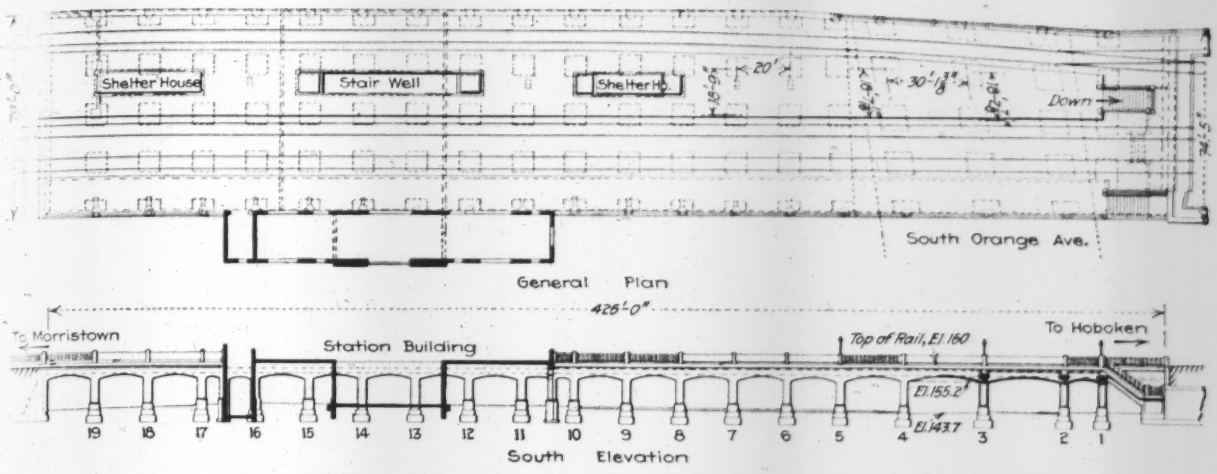


FIG. 2. GENERAL PLAN AND ELEVATION OF THE SOUTH ORANGE GRADE ELEVATION

Details of the crossing are shown in Fig. 2. A view of it is in Fig. 1. It will be seen that it carries three tracks, with two platforms—an island one with shelter houses and an interior one reached from the station proper. On account of property-line irregularities the structure varies from 79 ft. in width at the west abutment to 74 ft. 5 in. at the east abutment. The flat slabs are carried on columns generally spaced 18 ft. 9 in. c. to c. transversely, a spacing dictated both by economy and by the location of the platforms and stairway openings. Longitudinally, columns are spaced on 20-ft. centers, except where the skew of the bridge requires the extension of the span to 30 ft., which makes a number of irregular panels, as shown in Figs. 2 and 3.

The columns for the typical 18-ft. 9-in. by 20-ft. panels are circular in section and 34 in. in diameter. Along the curb line the columns are 36 in., while those in the center of the roadway are 40 in. The slab is 20 in. thick for a typical panel, increased to 26 in. for the roadway span.

Architectural features include a handsome railing, arched fascia girders on the showing faces, colored matt-glazed tile panels at the head of each pilaster, bush-hammering of the exterior surfaces and the use of a

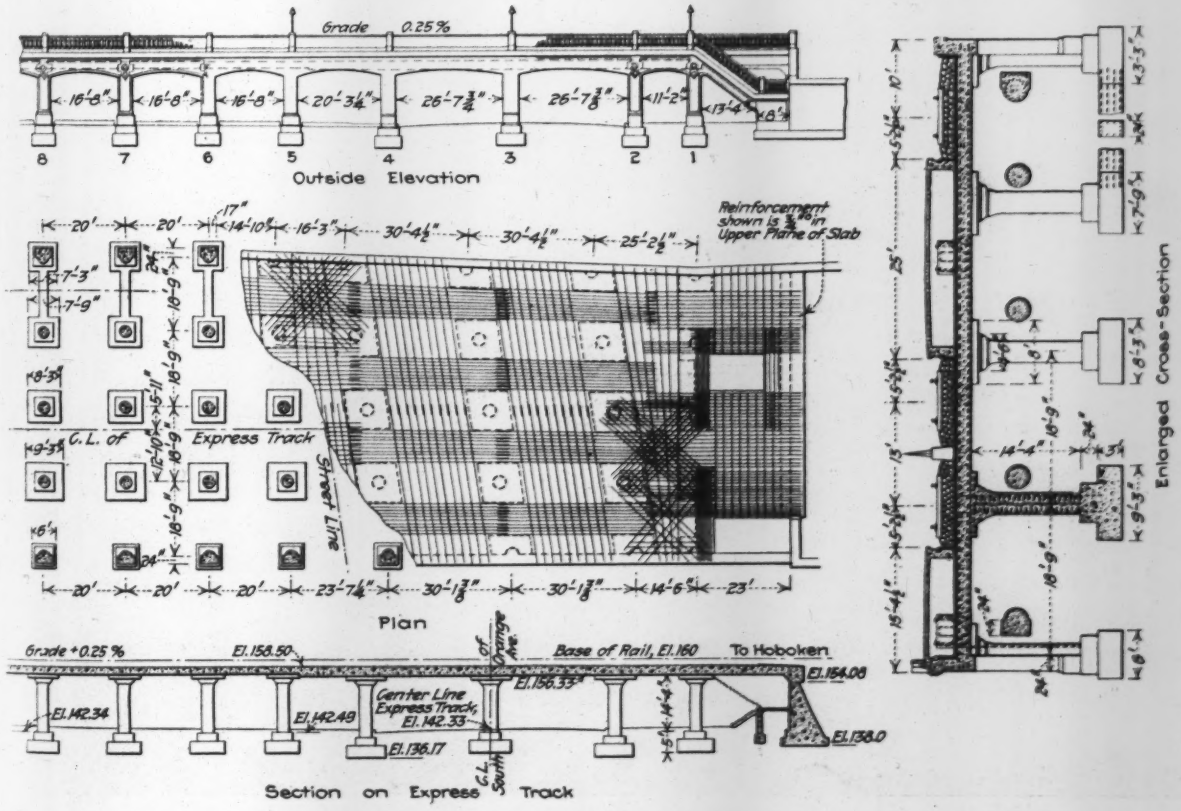


FIG. 3. DETAILS OF CONCRETE STRUCTURE AT SOUTH ORANGE GRADE ELEVATION

dark-red wire-cut brick for the station building. The platform canopies are of structural steel, with concrete roof slabs covered with green tile, similar to that on the waiting-room roof.

The flat-slab floor is on the cantilever flat-slab system, controlled by the Concrete Steel Products Co., Chicago.

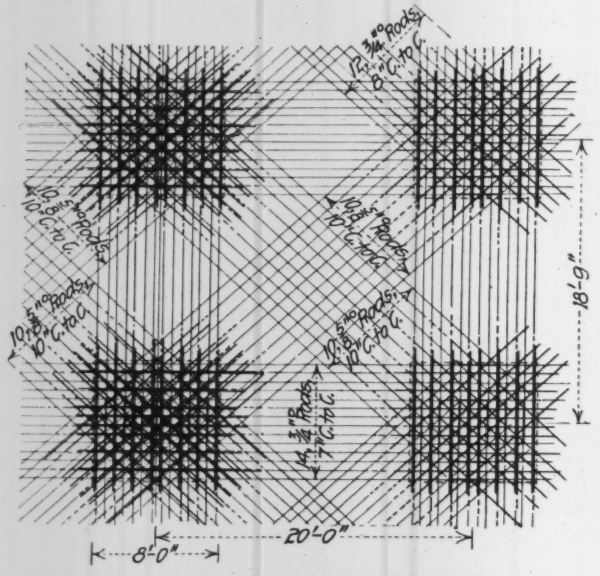


FIG. 4. DETAILS OF THE REINFORCEMENT OF A TYPICAL FLAT-SLAB PANEL

It consists of a four-way reinforcement of a slab with approximately one-half of the rods of each band bent up over the column capitals to provide reinforcement for negative bending moments at these points. The reinforcing details are shown for a typical panel in Fig. 4.

The effective depth of the columns is increased by drop panels, also serving to reduce shearing stresses. The method of design is explained as follows by A. B. Co[illegible], Assistant Engineer of the Lackawanna.

The structure was designed to carry two 233-ton Mikado engines (four drivers 5 ft. 6 in. c. to c., 60,000-lb. axle loads) en train on each of the three tracks. Owing to the high rate of speed of the trains across the viaduct, a large live-load impact factor was added, which amounted to 68% of the static live-load and was proportioned in the following ratio: Impact $= \frac{LL \times LL}{LL + DL}$. The maximum negative and positive live-load moments were determined by the theorem of three moments for wheel concentrations of the two engines followed by a trainload of 6,000 lb. per lin.ft. of track over seven panels for both the irregular spans over the avenue and the 18-ft. 9-in. by 20-ft. typical panels. For maximum moments all three tracks were considered loaded. In addition to the longitudinal continuity of the slab over the columns there is a transverse continuity. However, the moments that were computed in the longitudinal direction were distributed transversely in accordance with the method of computing simple beam reactions and the impact factor determined by the formula previously mentioned. Due to the considerable amount of fixedness at the columns and the transverse continuity, $^{12}/_{15}$ of the computed moment was used, thus giving end moments equivalent to $We^2 \div 15$ for determining the amount of steel required over the columns.

Following the method of calculating the negative moment over the columns, the slab at the center of the panel was proportioned for the maximum positive moment, reduced in the same ratio as was the negative moment. The reinforcement required was then distributed among the direct and diagonal bands in accordance with the coefficients of $^1/_{40}$ and $^1/_{60}$ respectively, or a ratio of 3 to 2, as established by the Chicago building code.

The columns were designed as hooped columns, with both spiral and vertical reinforcement to take the maximum reactions due to the conditions of loading, as heretofore described. The footings of the two columns of each bent, under the westbound track, are connected throughout by reinforced-concrete ties to insure a more uniform distribution of the load on these footings. The footings are designed for a soil pressure of 3 tons per sq.ft. on a good gravel subsoil.

The unit stresses used in the design of this work were 650 lb. per sq.in. for extreme fiber compression in the concrete, 16,000 lb. per sq.in. for tension in the steel and 500 lb. per sq.in. for concrete columns exclusive of the steel reinforcement.

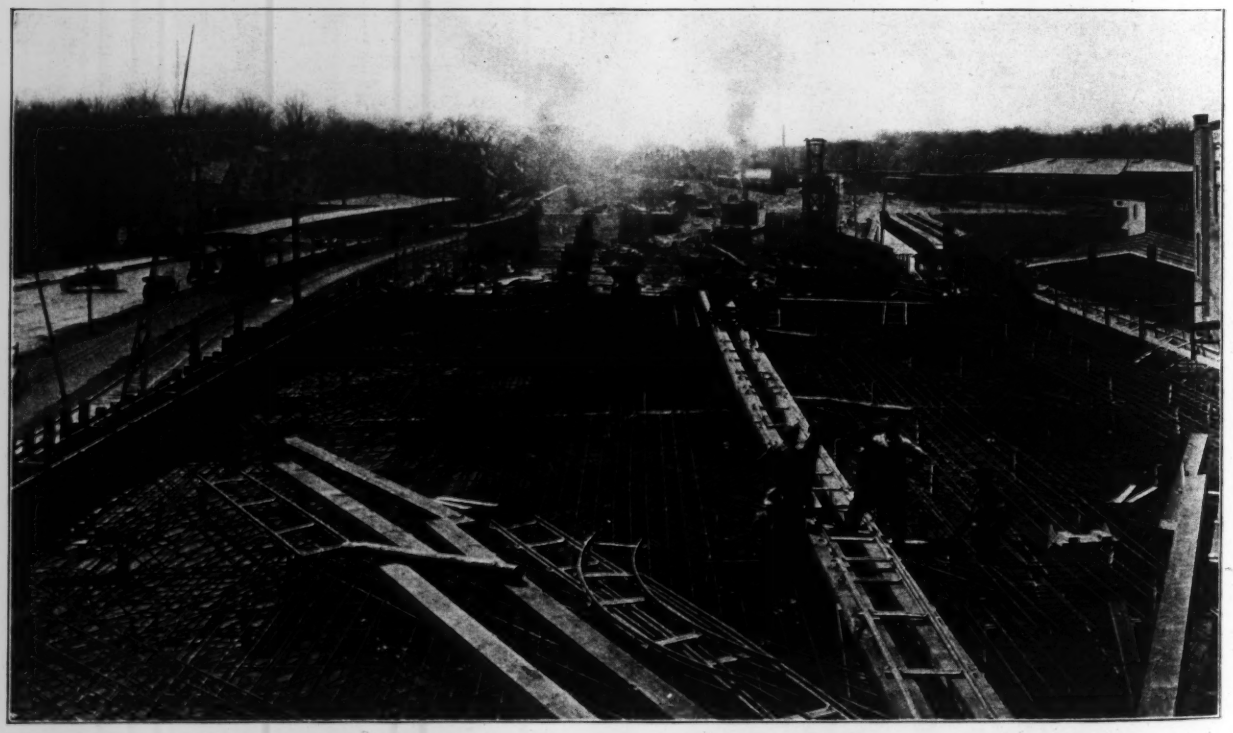


FIG. 5. VIEW OF SOUTH ORANGE FLAT SLAB UNDER CONSTRUCTION

No expansion joints were placed in the bridge proper, but the slab is reinforced for stresses due to temperature variation by bands of reinforcing steel between each row of columns, both longitudinally and transversely. There are ten ¾-in. rounds in each longitudinal band and seven in each transverse band, spaced uniformly between the drop panels and placed in the upper plane of the slab. These are shown in Fig. 3. The bars of the four-way reinforcement that are not bent up over the columns to resist the negative moment are lapped to furnish continuous reinforcement, which provides additional resistance to temperature changes. Where the stair wells occur, the drop panel was extended for half of its width between the corners of the stair wells and the last row of columns, giving a section of increased depth along the sides of the openings.

It was necessary to carry on all the construction of the South Orange improvement while providing for the very heavy suburban commuting traffic. To do this, the tracks were shifted about 30 ft. outside of the center of the right-of-way and the fill brought in from the west. In the construction of the station and crossing at South Orange the columns and their bases were first placed. Then the spiral reinforcement for the columns was securely fastened to the stubs of the column bases and the falsework for the slabs erected. Sheet-metal forms were used for the columns, which were poured to an elevation about 2 in. above the under side of the drop panel. These columns were allowed to attain their initial set before the slab was poured. All steelwork of the slab was then placed, mainly being supported on small 4x4-in. concrete posts or blocks, resting on the floor forms.

An effort was made to get as much of the concrete of the slab poured at once as was practicable. To do this, it was divided into three sections for the full width of the viaduct. The first section, 135 ft. long, commencing from the east abutment, included 5½ panels and contained 886 cu.yd. In order to avoid construction joints in the slabs through any part of the station the last section was made 210 ft. long and covered 10½ panels with 1,110 cu.yd. of concrete. This was all poured in a continuous operation. A mixer was stationed at each end of the work, a ¾-yd. stationary on the approach fill at the east abutment and a ½-yd. mixer on a flat-car that moved in from the west end as the work progressed. Concrete was distributed to the forms on buggies mounted on tracks, such as are shown in the view in Fig. 5.

The slab was waterproofed with three plies of Minwax saturated cloth laid in Minwax hard waterproofing applied hot. Under the platforms this membrane was protected by a 1½-in. layer of concrete, but under the tracks it was protected by two ¾-in. layers of asphaltic mastic mixed with torpedo washed gravel and furnished by the Johns-Manville Co.

The design and construction of the South Orange Improvement were carried out under the general direction of G. J. Ray, Chief Engineer. The station design was made by F. J. Nies, Architect for the railroad company, and was supervised by G. T. Hand, Division Engineer, and W. H. Spiers, Resident Engineer. A. B. Cohen, Assistant Engineer, superintended the reinforced-concrete design, which was approved by A. R. Lord for the Concrete Steel Products Co. The improvement was built by Hyde, McFarlin & Burke, New York City, with a contract to F. B. Hyde of that company for the station.

Illinois Drainage Conference

Land drainage in its various aspects of relation to conservation, sanitation and engineering economics was the subject of a conference held at the University of Illinois, Mar. 8 to 10. Its purpose was to stimulate interest in drainage and flood protection and the reclamation of swamp and overflowed lands in the state. The attendance was smaller than had been expected and consisted mainly of engineers, only a few drainage commissioners and others being present.

The papers were largely of a technical character, but covered a wide range of subjects. One group dealt with surveys, plans and construction. Professor McDaniel, University of Illinois, took up excavating plant and methods. Professor Stewart, University of Minnesota, spoke of the great desirability of standardization of plans, not so much in the interest of the engineer as in that of the landowners and to facilitate the legal proceedings.

Many plans now are too small or too large. They do not show the boundaries of drainage areas or they fail to give bench marks with which other engineers can connect. Where approval of projects by the courts is involved, there is much loss of time in examining plans that are not easily understood. Another important point is that, if the engineer prepares a plan which the landowner can easily comprehend, he tends to make the latter favorably disposed to both the drainage project and the engineer.

River conditions in Illinois were outlined by L. K. Sherman, Illinois Rivers and Lakes Commission, and R. I. Randolph, Chicago. Drainage as a matter of profit and public health was dealt with by Paul Hansen, Illinois Water Survey. The profit is due to cultivation, and improvement in public health is due to the elimination of malarial and mosquito-breeding conditions, as well as to the securing of dry building sites. He instanced one case where the expenditure of $390,000 in drainage work increased property values by $3,000,000 and rendered useless swamp land available for truck farming and healthful suburban districts.

The organization and financing of drainage districts was discussed by J. A. Harman, Peoria. Other lines of discussion related to drainage laws, soil conditions, drainage of railway lands, flood protection and the consideration of river control as a national enterprise. This last applied particularly to the Mississippi Valley.

A special line of thought was that of informing and educating people in the rural districts (who decide upon and pay for drainage work) as to the value of land drainage from economic and sanitary points of view. Dr. Hieronymus spoke of the methods being taken by the University of Illinois to develop the community spirit. E. E. R. Tratman, of *Engineering News*, suggested the advisability of utilizing farmers' institute meetings, Chautauqua meetings and the country press in spreading educational information throughout the rural districts and country towns in such matters of public importance as sanitation, land drainage, good roads, and other engineering projects.

One result of the conference was a movement to organize a drainage section of the Illinois Society of Engineers, open to drainage commissioners, lawyers, and others concerned with drainage work and projects.

Water-Works Chemicals Soar*

By W. F. Monfort†

In a paper presented before the Illinois Section of the American Water-Works Association the effect of the war on prices of chemicals used in water purification to Jan. 22 was discussed. Later developments promise no relief before the end of the current year or before the end of the war.

Under normal conditions buyers of chemicals for water treatment enter but the fringe of the market. The total volume of their purchases is slight as compared with the gross tonnage of lime for the building trades; of sulphate of alumina for textile manufacture and dyeing, tanning of leather and production of alum; of sulphate of iron for dyeing, tanning and the production of colors; of copper sulphate as a plant disinfectant (orchard spray), as the basis of paris green, and in metal plating; of bleaching powder in textile manufactures, as a disinfectant and in chemical processes; of chlorine, now replacing bleaching powder in chemical manufacture and textile bleaching; of soda ash in the manufacture of soap, glass and other chemical-technical products.

Fundamental to production of the sulphates is sulphuric acid; on account of the enormous demand for high explosives—gun cotton, nitroglycerin, picric acid (lyddite, melinite), trinitrotoluol—every factory producing sulphuric acid is running to capacity, with its output contracted ahead. The price has risen about 250%. With this advance market prices of sulphate of alumina have risen. Since mid-February sulphate of iron has doubled in price, with the prospect of shortly paralleling the 250% advance in acid. Copper sulphate has been influenced further by the advance in copper, and wholesale quotations have been steady at almost fivefold the normal price, since England forbade manufacture some five months ago, to maintain an undiminished supply of copper for munitions.

The fundamental process in the manufacture of bleaching powder is the electrolysis of sodium chloride (common salt), yielding chlorine and caustic soda. Both these products are required in the manufacture of picric acid from benzol, which is first chlorinated, then nitrated and finally treated with alkali, to remove chlorine and complete the synthesis:

C_6H_6 to	$C_6H_5.Cl$ to	$C_6H_2(NO_2)_3.Cl$ to	$C_6H_2(NO_2)_3.OH$
Benzol	Chlor-benzol	Chlor-trinitrobenzol	Picric acid
			Trinitrophenol

The significance of this process in affecting prices in this country is illustrated by the fact that a single order placed in January for 1916 delivery will require approximately (not allowing for waste in the several processes) sufficient chlorine to sterilize 4,400,000 million gallons of ordinary filter effluent and a weight of sulphuric acid equivalent to 570 thirty-ton cars of sulphate of alumina or 850 thirty-ton cars of sulphate of iron. These quantities deducted from the available supply of water-works chemicals must have a significant effect upon prices, since they exceed the annual demand of several cities the size of St. Louis.

*Condensed and brought to date by the author from a paper presented in January, 1916, before the Illinois Section of the American Water-Works Association.

†Consulting Chemist, 506 North Vandeventer Ave., St. Louis, Mo.

Bleaching powder has advanced to sevenfold its normal price. The price of liquid chlorine has doubled. The difference in advance in these closely related products is due to the fact that under older conditions chlorine was a byproduct of the soda manufacture, with an overproduction for which a market was sought. Established practice for a century has made bleach, prepared by absorbing chlorine in lime, the customary form in which the bleaching agent was shipped. Textile producers are equipped for the use of hypochlorite. Latterly, chlorine, liquefied by refrigeration, shipped in 100-lb. cylinders, has been gaining the approval of textile and pulp manufacturers, while its greater economy and convenience of application make it preferable in chemical processes generally. Of five bleach factories in this country, one has ceased altogether the production of hypochlorite. Two are running to full capacity, but give no quotations and make no deliveries on new contracts. One has been sold to a manufacturer of liquid chlorine, and its output of bleach is diminished. A fifth has increased the output of liquid chlorine, with a corresponding decrease in the production of bleach. The 1916 production of bleach was sold up in November last.

Importations of hypochlorite of lime have practically ceased. In past years the supply from Germany and England was as follows:

BLEACH IMPORTS FOR CALENDAR YEARS

Year	Weight, Lb.	Value per Lb., Cents
1912	72,706,732	0.82
1913	61,695,077	0.82
1914	34,539,934	0.96
1915	7,564,473	1.36

WHOLESALE NEW YORK QUOTATIONS TO MAR. 4, 1916

	Sulphuric Acid (60° Bé.) per Cwt.	Sulphate of Alumina per Cwt.	Sulphate of Copper per Cwt.	Sulphate of Iron per Cwt.	Hypochlorite of Lime per Cwt.
Normal	$0.80@0.85	$0.80@1.10	$4.50@ 4.75	$0.55@0.60	$1.25@ 1.35
Jan. 29	2.00@2.50	3.00@4.00	20.00@23.00	0.55@0.60	@13.00
Feb. 5	2.00@2.50	3.00@4.00	20.00@22.00	0.55@0.60	13.00@14.00
Feb. 12	2.00@2.50	3.00@4.00	20.00@22.00	0.55@0.60	12.00@13.00
Feb. 19	2.00@2.50	3.00@4.00	20.00@21.00	0.75@1.00	12.00@13.00
Feb. 26	2.00@2.50	3.00@4.00	20.00@21.00	0.75@1.00	9.50@10.50
Mar. 4	2.00@2.50	3.00@4.00	20.00@21.00	0.75@1.00	10.50@12.50

The present situation with regard to water-works chemicals is: Lime alone is unchanged in price. The 1916 production of sulphuric acid, soda, chlorine and bleaching powder is practically sold up. Contracts for 1917 are now making. Production of the sulphates of alumina, copper and iron is limited and will probably remain so while the great demand for sulphuric acid continues. Water-works purchasers are having difficulty in securing annual contracts at any prices, save as old customers appealing for continuance of orders. Small quantities from limited stocks (the surplus of resting orders) in second hands are available from time to time. The water-works buyer, a minor factor in a world market, is dependent largely upon chance lots and will be compelled to secure what he must have at prices fixed by the world demand, unless he can gain a hearing with producers through long-term contracts at special prices.

Anti-Typhoid Inoculation has been used by the Canadian Pacific Ry. with marked success. Before the practice was adopted there were 320 cases of typhoid fever in 1911 on the Alberta division. Two years or so ago the company offered free vaccination or inoculation to all employees desiring it. Of 24,000 employees, 5,500 were inoculated the first year, and 8,400 the second year, making a total of 13,900 inoculated and 10,100 not inoculated. The number of cases among those who had been inoculated was only two the first year and one the second year, or a total of three, compared with 220 the first year, 70 the second year and 290 for the two years among those who had not been inoculated.

News of the Engineering World

New York Subway Ventilation Plans Investigated

In the early summer of 1915 an active campaign was conducted in New York City against the plans to ventilate the new subways through open gratings in the sidewalks. It was alleged that the air escaping from these openings was foul, germ-laden and a serious menace to health. It was further alleged that pedestrians avoid walking on the open gratings and that this injures the value of the abutting property for show-window purposes. The newspapers took an active part in the campaign and published various suggestions from engineers and others as to alternative methods of ventilation in place of the open gratings in sidewalks.

After hearing protests from property owners, citizens' associations, etc., the Public Service Commission created a board of engineers to investigate and report, with recommendations, on the question of ventilation of the subways. The board was made up of William Barclay Parsons, S. L. F. Deyo, J. Vipond Davies, Lewis B. Stillwell and Alfred Craven, Chief Engineer of the Public Service Commission. The report of this board, dated Feb. 24, has just been made public. The conclusion of the board is that ventilation through sidewalk gratings is the least objectionable and most practicable method for ventilation of the new subways.

The necessity for ventilation of the subways arises chiefly from the enormous amount of heat discharged into them from the electric energy used in the propulsion of the trains. Some heat also is discharged in the operation of the lighting system and from the bodies of the passengers traveling in the subway. The great bulk of the heat in the subway, however, is due directly to the energy used in the movement of the trains. Such difficulties from excessive temperature of subway air have not been found in any other cities where subways are operated, because in no other city having an extensive subway system is the summer temperature as high as in New York City or are the weight, speed and number of trains such as to discharge an equally large amount of heat.

Besides this, the plans for the original subways were violently criticized before construction on the ground that the foul water and gas in the earth would leak into the subways and convert them into sewers. In order to meet this popular criticism extra precautions were taken in waterproofing the subway structure by layers of felt and asphalt. While the waterproofing was successfully effected, the material used acted as an excellent non-conductor of heat, to obstruct the transmission of the interior heat of the subway into the earth. In building the new subways waterproofing is being used only where it is necessary.

The popular belief is that the subway air is foul, is laden with disease germs and is dangerous to health. This belief has been fostered by sensational newspaper articles. Shortly after the subway was opened, in 1905, elaborate tests were made by Dr. G. A. Soper and Dr. Charles F. Chandler, two eminent authorities on chemistry and sanitation. The report of these experts showed that the air of the subway was at that time practically the same in carbonic acid content as the air of the street and was purer than the air of most public assembly halls. Similar thorough tests on the air of the subway have been made by G. L. Lucas, under the direction of the Board of Engineers, and have confirmed the results obtained by Dr. Chandler and Dr. Soper a dozen years ago. The tests, extending over three months, showed the average oxygen content of air in the street at 20.6% and of air in the subway at 20.64%. The carbonic acid gas content in parts per 10,000 varies from 4 to 5 in air in the street, and an average of all the tests in the subways was 6.2 parts. Tests of the bacteria in street air and subway air showed an average of 255 bacteria per cubic meter for street air and 219 bacteria in subway air.

These figures, which are brief summaries of results given in the report in much greater detail, show that the only objectionable thing in the subway air is its excessive heat in the summer months. When these facts were established in 1905, the Rapid Transit Commission installed apparatus to change the air in the subway more frequently, in order to carry off more rapidly the excessive heat. Ventilating openings were introduced in the walls of the subway between stations, which were connected by galleries with open gratings in the street sidewalks. The piston action of the trains in the subway, as well as the natural ventilation currents occurring when the temperature in the subway is higher than that of the street air, produces currents of air through these gratings.

The Board of Engineers has studied the objections made to the ventilating gratings in the sidewalks and finds that some of the property owners who have protested against these gratings have themselves installed gratings for private purposes, such as ventilating heated basements, boiler rooms, etc. Tests showed that from some of these gratings inserted in the sidewalk by private property owners air was being discharged at temperatures far above the street temperature, in one case reaching a maximum of 184° F. The temperature of the air issuing from the average subway opening, on the other hand, is only 5° to 7° above the temperature of the outside air. The velocity of the air currents from the private gratings in the sidewalks ranged from 1 mi. to 12 mi. per hr., while the air issuing from the subway gratings even when trains were passing, had a velocity of only 1.17 mi. per hr.

The Board of Engineers held public hearings at which property owners and their representatives, including some engineers, appeared to protest against the sidewalk gratings and to urge that some other method of ventilation should be adopted. The suggestions for alternative methods of ventilation are grouped by the board into four classes, as follows: (1) Chemical treatment of the air; (2) control of air current from subways by closing station entrances; (3) ventilation openings elsewhere than

in the sidewalk, especially use of chimneys in private buildings for forced-draft exhaust; (4) refrigeration.

In discussing these plans for ventilating the subway air the suggestion of chemical treatment is answered by the fact that the subway air is for all practical purposes already as pure as the street air. Control of subway air currents by placing revolving doors in station entrances would be impossible with enormous crowds.

The third suggestion, discharging air from the subway elsewhere than through sidewalk gratings, is discussed at great length by the board. The use of chimneys along the route for ventilation is discussed sufficiently to show its utter impracticability. The enormous volumes of air necessary to be discharged from the subways are so great that it would destroy the chimneys' usefulness for power purposes, were the subway air to be discharged into them. To ventilate the subway through shafts with a system of blowers would cost, for the section between Brooklyn Bridge and 96th St., more than $4,000,000 to install; and the annual cost of operation would represent the interest on about $10,000,000, or a total capitalized cost of $14,000,000, which is equivalent to about $2,000,000 per mile of this section of the subway, and this sum approaches the original cost of construction. This estimate, moreover, does not include the very heavy cost of the real estate, easements, etc., that would have to be acquired to construct such ventilating shafts.

Artificial refrigeration to cool the subway air has been exhaustively examined by the board. Careful measurements have been made of the amount of heat liberated in the subway, which is as high as 2,380 B.t.u. per hour during rush-hour traffic and 6,600 B.t.u. per hour per foot of platform at express stations. The estimates prepared by advocates of refrigeration for cooling the subway air have been investigated by the board, which finds that the estimates do not provide sufficient plants for ventilation purposes, which ventilation is necessary in any event on account of the great crowds using the subway. The refrigerating plant proposed, moreover, would lower the temperature only 2 or 3° F. The cost of the plant and its operation would be out of all proportion to the benefit gained.

The final conclusions of the board are as follows:

That of the various plans proposed for ventilation which depend primarily upon fans or blowers there is none that can be regarded as practical, efficient and safe which does not involve, on the one hand, prohibitive cost, or, on the other, inconvenience and annoyance to the public using streets and sidewalks—more serious, in our judgment, than any annoyance resulting from the use of the contemplated sidewalk gratings.

That in the opinion of our committee the natural method of ventilation by the piston action of trains, with intake and discharge openings of large area and supplemented by fans for emergency use, is the most effective method which can be applied at practicable cost and provides the maximum degree of safety against unforeseen effects of interruption of traffic due to accident.

That in subways constructed with more or less continuous grating openings along the length of the structure the natural method of ventilation is adequate without auxiliary mechanical installation. That in the application of this natural method the location of the gratings required should be closely studied, in order to minimize their occupation of sidewalk area at any one point, and that when care has been exercised in this matter such gratings are less objectionable than any practicable alternative method of ventilation which would secure for the public using the subways equal safety and comfort.

That experiments made in the Fourth Ave. subway point to the conclusion that minor modifications in the subway structure may be advisable, such as closing some of the openings in the central partition wall and possibly extending partition walls through stations.

Panama Slide Commission Presents Its Report

The preliminary report of the commission appointed by President Wilson, Nov. 18, to visit the Panama Canal and report upon its slides has just been made public. Dr. Charles R. Van Hise, President of the University of Wisconsin, was chairman of the commission, and among the well-known engineers who were members were Gen. H. L. Abbott, R. C. Carpenter, Arthur P. Davis, John R. Freeman, J. F. Hayford and H. F. Reid.

The commission believes that, after the present difficulties have been overcome, navigation through the canal is not likely again to be seriously interrupted. Nearly all the important movement of sliding ground is concentrated within about one mile in length, where Culebra Cut is the deepest. About 9,000,000 cu.yd. will have to be removed between the two Culebra slides, and the dredges can remove about 1,000,000 cu.yd. a month. The commission believes, however, that the time is probably not far off when the canal may again be opened for navigation, as the slower movement of the slides as excavation progresses will enable the dredges to keep pace with them while the canal is in use. The commission does not find that the great mass of rock in Gold Hill and Contractors' Hill has shown any signs of movement.

As a means of lessening trouble with slides, the commission recommends the covering of slopes with vegetation, the closing of cracks by earth-fills, a system of surface and tile drainage and careful surveys of ground adjacent to the canal to determine with accuracy when any sliding movement starts. The commission's final report will not be ready until April.

Military Roads and Bridges Described to Engineers

The construction of military roads, bridges and ferries and the selection of fords were described, Mar. 13, by Capt. S. L. Godfrey, Corps of Engineers, U. S. A., at the fifth lecture in the series arranged by the national engineering societies in New York City. The great importance of time and the subordination of cost in such work were emphasized at the outset.

The usual road work is in improving existing lines, although new roads around military obstacles may be made. Grades may be kept up to 6% for transportation, and those of 10 to 15% are not impossible for maneuvers. Earth roads are the type to be expected in American operations, and these give good service if ruts are kept filled and side ditches open. In poor ground, rock and corduroy are satisfactory for wagons, but are bad for motor trucks. Culverts are kept down to the simplest pipes.

Rivers may preferably be forded, except for continuous travel. A maximum depth of 3½ ft. can be taken by infantry, 4½ ft. by cavalry and 3 ft. by wagons—if the banks are low, bottom hard and current moderate. The hydraulic conditions need to be studied in selecting a ford, for a diagonal bar may give a crossing where there is no direct passage. Fords are marked by range lines and lights. Marshy banks and poor bottom may be improved.

Ice may be used as a temporary bridge, when 3 in. will support a few men; 4½ in., a few cavalry troopers;

in., wagons and guns; and 9 in., the heaviest army loads. Bridges have their positions fixed by tactical considerations, but the type is selected by the engineers. Pontoon bridges are usually first thrown across streams of size, but should be replaced by trestle bridges later, so that the pontoons may be released for use in front. The present American pontoon equipment was designed by a board of engineers just before the Civil War, incorporating various features seen abroad and arranging for mule-wagon transportation. Their great success was demonstrated in 1861-65. Two designs are used—one all wood and one of wood frame and canvas cover, the latter type being light enough so that it may be carried along with an advance cavalry column. Each engineer battalion carries wagon trains for 1,900 ft. of bridge. The mules are an important factor and have to be trained for the service; reliance is not placed on the quartermaster department for transportation. Motor cars may be utilized at times, but usually they cannot approach the banks and mules have to be used. The steel and aluminum boats now used abroad are not liked here.

Vermont Society of Engineers Holds Annual Meeting

The Vermont Society of Engineers held its fourth annual meeting at Burlington on Mar. 9. The heaviest snowstorm of the winter, which blockaded the railways, interfered with the attendance, but about 40 members were present. The total membership of the society was shown by the secretary's report to be 118. Papers were read on the "Manufacture of Hydrated Lime in Vermont," by G. C. Thompson, Assistant Superintendent of the Vermont Marble Co.; on the "Waterproofing of Concrete," by Prof. C. W. Dix, University of Vermont; and on "Causes of Failure in Concrete Work," by F. O. Sinclair, City Engineer of Burlington.

The officers elected for the ensuing year are: President, H. M. McIntosh, Burlington; vice-president, B. M. Hayward, Montpelier; director, F. W. Denison, St. Albans; secretary, G. A. Reed, Montpelier; treasurer, Prof. A. E. Winslow, Northfield.

At the annual dinner in the evening the retiring president, A. C. Grover, City Engineer of Rutland, reviewed the past history of the society. "The Engineer's Opinion on Public Questions" was the subject of an address by Charles Whiting Baker, editor-in-chief of *Engineering News*.

The society's Committee on Public Policy reported a proposed code of ethics, which it was voted should be sent out to the members for letter ballot on its adoption. The code is substantially identical with that adopted in 1911 by the American Institute of Consulting Engineers and published in *Engineering News* of June 29, 1911. It is as follows:

It shall be considered unprofessional and inconsistent with honorable and dignified bearing for any member of the Vermont Society of Engineers:

1. To act for his clients in otherwise than in a trustworthy manner or to accept any other remuneration than his direct charges for services rendered his clients, except as provided in clause 4.

2. To accept any trade commissions, discounts, allowances or any indirect profit or consideration in connection with any work which he is engaged to design or superintend, or in connection with any professional business which may be intrusted to him.

3. To neglect informing his clients of any business connections, interests or circumstances which may be deemed as influencing his judgment or the quality of his services to his clients.

4. To receive, directly or indirectly, any royalty, gratuity or commission on any patented or protected article or process used upon work in which he is retained by his clients, unless and until receipt of such royalty, gratuity or commission has been authorized in writing by his clients.

5. To offer commissions or otherwise improperly solicit professional work either directly or by agent.

6. To attempt to injure, directly or indirectly, the professional reputation, prospects or business of a fellow-engineer.

7. To accept employment by client while the claim for compensation or damages, or both, of a fellow-engineer previously employed by the same client and whose employment has been terminated, remains unsatisfied, or until such claim has been referred to arbitration, or issue has been joined at law, or unless the engineer previously employed has neglected to press his claim legally.

8. To attempt to supplant a fellow-engineer after definite steps have been taken toward his employment.

9. To compete with a fellow-engineer for employment on the basis of professional charges, by reducing his usual charges and attempting to underbid after being informed of the charges named by his competitor.

10. To accept any engagement to review the work of a fellow-engineer for the same client, except with the knowledge or consent of such engineer or unless the connection of such engineer with the work has been terminated.

New Business Manager for "Engineering News"

Frederick P. Burt, who was connected with *Engineering News* from 1887 to 1905 and was for 13 years business manager of the Engineering News Publishing Co., has returned to *Engineering News* as its manager. Mr. Burt was educated in Canada, and his early professional work was done in that country in the field of civil and sanitary engineering and surveys for the Canadian Government. Since his resignation from *Engineering News* in 1905, Mr. Burt has been the publisher of the *American Architect* and in more recent years has been business manager of the M. C. Clark Publishing Co., Chicago.

All New York State Highway Bridges Under Scrutiny

The study of New York State highway bridges, as to their safety and adequacy under present-day traffic, for a year has been in the hands of a special committee of the Legislature (C. O. Pratt, Cambridge, N. Y., chairman) and a coöperating committee of the New York State Automobile Association (composed of G. A. Ricker, Consulting Engineer, Albany; F. A. Hermans, Troy, Bridge Engineer of the State Highway Department; and J. L. Baker, Middleburgh). The committee was given $6,000 to support its investigation.

A preliminary progress report has just been made to the legislature, showing the conditions disclosed by a circular tour over typical state routes—through Cobleskill, Oneonta, Binghamton, Elmira, Watkins, Geneva, Auburn, Syracuse, Utica, Little Falls, Amsterdam and Schenectady. In all 218 bridges were examined—or one for each 2.18 mi. of road (which is to be compared with the known figures of 34,000 bridges in the state, or one to 2.25 mi. of highway). There were seen 119 of 5- to 20-ft. length, 58 of 20- to 50-ft., 28 of 50- to 100-ft., and 13 of over 100-ft. span. The examination showed 27 of 3 tons capacity or less, 16 of 5 to 8 tons, 13 of 8 to 10 tons, 1 of 10 to 14 tons, 125 of 15 tons, and 9 of over 15 tons capacity. In general, the shorter bridges have the greater capacities. The committee reports that the

present capacity required by traffic is four times that demanded in 1900 and that all bridges should be built for 15 or 16 tons load.

The committee has not presented a plan for the rebuilding, which would cost $30,000,000 and at present progress would occupy 40 years; a request has been made for continuing the work of the committee, however, as two thirds of its original appropriations of $6,000 is still unexpended.

A Railway Creosoting Plant will be built by the Boston Elevated R.R. for treating crossties. G. B. Shipley, of Pittsburgh, will design the plant and superintend its construction.

The Division St. Bridge Collapse, Spokane, Wash., has become practically a closed case, through the settlement of the last damage claims. The claims paid, or to be paid, by agreement total about $70,000, according to the "Spokesman-Review." This amount covers 5 deaths and 17 cases of personal injury. The city pays two-thirds of the amount, the Washington Water Power Co. one-third. No further action in investigating the cause of the failure is expected.

The Railway Builders' Strike on the Alaska Government railroad lasted from Feb. 7 to Mar. 7. The original strike was by the track layers, who demanded an increase in pay from 37½c. an hour to 50c. an hour. The strike was called off under an agreement that a wage scale should be fixed in conference between the Alaskan Engineering Commission and a committee representing the workmen's union. Any increase in wages will be made retroactive from the date of resumption of work.

Steam Invades the Home of Water Power—A steam power station of 60,000-kw. capacity is now under construction in Buffalo, N. Y., for the Buffalo General Electric Co. The installation will include three 20,000-kw. turbo-generators with five boilers of approximately 13,000 sq.ft. heating surface each, the usual steam and electric auxiliaries, coal-handling apparatus and trestle, and intakes and discharges for the condensing system. The Stone & Webster Construction Co., Boston, is the constructing engineer.

Garbage Grease at the High Price of $6.26 per 100 lb. will add an estimated $30,000 to the revenues of the Cleveland municipal garbage-reduction works for the next six months. Three bidders offered the price named, and three others put in lower bids. The price received a year ago was $4.40. The recent bid is the best one Cleveland ever received for garbage grease. The high price is said to be caused largely by the active demand for glycerin for use in the manufacture of explosives and for red oil for dyestuffs. This is interesting in view of the belief expressed at Cleveland a year ago (see "Engineering News," Mar. 18, 1915) that the European War would cause a slump in the price of grease.

The Pennsylvania Bureau of Township Highways has divided the state into five districts, and five men have been promoted from the ranks to act as assistant engineers in charge of these districts, as mentioned in the "Personals" columns. The object of this change is to facilitate the work of the bureau and to bring it and the State Highway Department into closer touch with the township supervisors and the public. Under this arrangement, surveys for improvements contemplated by the township supervisors can be made by the engineer in the district, without having to wait for a man to be sent out from the Harrisburg office. The formation of these districts and the several promotions are effective Apr. 1.

Two 14-Ft. Reinsch-Wurl Sewage Screens are to be installed at the foot of the Dyckman St. sewer, Borough of Manhattan, New York City. The screens will be located in a brick building 35x45 ft. in plan, located adjacent to the 5x9-ft. combined sewer at about 60 ft. distance from the mouth of the sewer. The contract has been let, and work is in progress on the foundation of the building and on the portion of the outlet sewer between the building and the water which is to receive the screened sewage. Contract for the superstructure of the building and for the machinery will be let. The estimated cost of the first installation is $40,000 and of the entire ultimate plant is $75,000. The annual operating expense is estimated at from $2,500 to $3,000. It is expected that the plant will be in operation by Jan. 1, 1917. Charles E. Gregory is chief engineer of the bureau of sewers for the Borough of Manhattan, and John H. Weinberger is assistant chief engineer. Walter Cohen is assistant engineer in charge of the design, and G. L. Christian of the construction of the screening plant.

PERSONALS

Mr. Albert J. Gardetto, of Passaic, N. J., has been elected Vice-President of the Old Colony Construction Co., Boston and New York City.

Mr. W. M. Vandersluis, Signal Engineer of the Illinois Central R.R. at Chicago, has been appointed Consulting Signal Engineer of the Central of Georgia Ry., with headquarters in Savannah, Ga.

Mr. E. P. Worden, M. Am. Soc. M. E., formerly Manager of the Fred M. Prescott Steam Pump Works, Milwaukee, has been appointed Chief Engineer of Henry R. Worthington, Harrison, N. J.

Mr. Howard W. Holmes, Assoc. M. Am. Soc., C. E., formerly State Highway Bridge Engineer of Oregon, has opened an office as Consulting Engineer at 815 Northwestern Bank Bldg., Portland, Ore.

Mr. George Kingdon Parsons, M. Am. Soc. M. E., has located his main offices in the Equitable Building, 120 Broadway, New York City. He will continue his office in the Riggs Building, Washington, D. C.

Mr. W. Walley Davis, M. Am. Inst. M. E., Superintendent of the byproduct coke ovens of the Semet-Solvay Co. at Steelton, Penn., has been made Manager of the Byproducts Coke Corporation, Chicago, Ill.

Mr. C. P. Bowie, Assoc. M. Am. Soc. C. E., formerly Engineer of the Associated Pipe Line Co., San Francisco, is now Petroleum Engineer for the United States Bureau of Mines, with headquarters in San Francisco.

Mr. Ellis Soper, M. Am. Soc. M. E., President of the Soper Engineering Co., Chattanooga, Tenn., has been appointed Chief Engineer of Design and Construction of the plant of the Cuban Portland Cement Co., Havana, Cuba.

Mr. W. A. Van Duzer, Assoc. M. Am. Soc. C. E., Assistant Engineer of the Pennsylvania State Highway Department in charge of District No. 6, with headquarters at York, has been transferred to Scranton to succeed Mr. Tebbs, promoted.

Mr. Frederick T. Crane, City Engineer of Orange, N. J., for the past 22 years, has been nominated member of the New Jersey State Department of Health to succeed Mr. M. N. Baker, Montclair, N. J., whose term of office will expire on July 1.

Mr. Edward C. Sherman, M. Am. Soc. C. E., of Rourke & Sherman, Consulting Engineers, Boston, Mass., has been elected Secretary of the Old Colony Construction Co., Boston and New York City. He will continue his consulting practice in Boston as heretofore.

Messrs. Paul P. Whitham, Assoc. M. Am. Soc. C. E., and Llewellyn Evans, Assoc. Am. Inst. E. E., have organized the Industrial Engineering Co., with offices in the New York Block, Seattle, and at 725 Commerce St., Tacoma, Wash. The company will engage in consulting practice.

Mr. William H. Becker, formerly in the employ of the Arizona Eastern Railroad Co., at Globe, Ariz., has been engaged as consulting engineer for the Gila County Road Department in the construction of roads under a $350,000 bond issue. He will make his headquarters in Globe.

Mr. P. P. Bourne, M. Am. Soc. M. E., formerly Chief Engineer of the Blake & Knowles Steam Pump Works, East Cambridge, Mass., is again associated with the International Steam Pump Co. in connection with special engineering work located at the company's main office, 115 Broadway, New York City.

Mr. R. E. Harrison, recently Assistant City Engineer of Grand Rapids, Mich., and resident engineer of construction during the building of the filter plant of that city, resigned his position on Mar. 1 to become Vice-President and Manager of the L. A. Boulay Co., Civil and Sanitary Engineers, Toledo, Ohio.

Mr. Joseph C. Allison, Assoc. M. Am. Soc. C. E., until recently Assistant General Manager and Chief Engineer of the California Development Co., Calexico, Calif., has resigned to engage in consulting engineering work at Calexico. He has been connected with the California Development Co. for nearly 15 years.

Mr. George M. Basford, M. Am. Soc. M. E., recently Chief Engineer of the Railroad Department of Joseph T. Ryerson & Son, New York City, is President of the newly organized Locomotive Feed Water Heater Co., 30 Church St., New York City. Mr. Basford will also form a new concern to handle advertising accounts of railway-supply companies, to be known as the G. M. Basford Co.

Mr. P. M. Tebbs, Assistant Engineer of the Pennsylvania State Highway Department, who has been in charge of District No. 12, with headquarters at Scranton, has been promoted to the position of Engineer of Construction. He will fill the vacancy caused by the resignation of John T. Gephart, Jr., and will have headquarters at Harrisburg.

Mr. W. H. Stewart, for the past 15 years Surveyor to Lloyds Register of Shipping in San Francisco, has resigned to engage in business as a consulting engineer and marine surveyor, with offices at 260 California St., San Francisco, Calif. He will give special attention to the supervision of design, construction and repairs of vessels and their machinery.

Mr. Fred R. Hesser, for the past three years Assistant Engineer of the Kansas State Board of Health, has resigned to become Manager of the Universal Concrete Construction Co., Kansas City, Kan. Mr. Hesser graduated from the University of Kansas in 1910. He has served for two years as City Engineer of Beloit, Kan., and County Surveyor of Mitchell County and one year as Assistant Highway Engineer of Kansas.

Messrs. Harrison W. Latta, M. Am. Soc. C. E, and J. Kinter Roberts, have formed a partnership under the firm name of Latta & Roberts, with offices at 363 Drexel Building, Philadelphia, Penn., to engage in heavy contracting, such as foundations, excavation, piledriving, wharf and trestle building and subaqueous work. Mr. Latta was formerly President of the Latta & Terry Construction Co., Philadelphia, and for the past five months has been a member of the staff of the Association of American Portland Cement Manufacturers.

Mr. R. H. Thomson, M. Am. Soc. C. E., has been elected one of the three new members of the City Council of Seattle, Wash. Mr. Thomson for many years has been in entire charge of the design and construction of the municipal improvements of Seattle, including the city water-supply. He was City Engineer of Seattle from 1892 to 1911; Chief Engineer of the Port of Seattle during 1911 and 1912; Chief Engineer of Strathcona Park, Victoria, B. C., from 1912 to 1915; and recently has practiced as a consulting engineer in Seattle.

Mr. Joseph B. Baker, since 1912 Assistant Supervisor of the Pennsylvania R.R., at Newport, Penn., has been promoted to the position of Supervisor, Office of the Assistant to General Manager. Mr. Baker entered the service of the Pennsylvania in 1905 as rodman in the construction department. The following year he was transferred to the maintenance-of-way department and in 1909 was made transitman at Altoona, Penn. He was advanced to Assistant Supervisor at Watsontown, Penn., in 1910 and the next year was transferred to Newport.

Mr. C. H. Johnson, formerly Engineer of Construction of the Nashville, Chattanooga & St. Louis Ry., has resigned to become Superintendent of the Gould Contracting Co., Nashville, which is constructing various bridges and viaducts for the railroad. Mr. Johnson graduated from Vanderbilt University in 1890 and entered the engineering department of the railroad as rodman, rising through various ranks to the position of Engineer of Construction in 1910. He designed the Chattanooga Creek culvert and the Running Water viaduct and was in charge of grade reduction on the main line.

Messrs. Charles E. Parsons, M. Am. Soc. C. E., and Guy C. Simpson, have organized the firm of Parsons & Simpson, Engineers, with offices at 61 Broadway, New York City and San Antonio, Tex., for the purpose of carrying on a general engineering practice in the United States and Mexico. The firm is prepared to make preliminary surveys and investigations, to furnish plans and estimates and to supervise construction. Mr. Parsons has recently been President of the Ambursen Co., New York City, and both members of the firm have had wide engineering experience.

Mr. Washington B. Lewis, Assoc. M. Am. Soc. C. E., has been appointed Supervisor of the Yosemite National Park, California. Mr. Lewis graduated from the Engineering Department of the University of Michigan in 1907 and since that time has been a member of the United States Geological Survey. He was furloughed for survey work with the first and second National Geographic Society expeditions in Alaska, and in 1911 went to Argentina, where he was engaged for four years in making studies and surveys in connection with the investigation of the industrial possibilties of northern Patagonia, for the Government of Argentina.

Mr. B. J. Dalton, M. Am. Soc. C. E., Assistant District Engineer of the Fifth District, Valuation Division, of the Interstate Commerce Commission, located at Kansas City Mo., has been appointed Chairman of the Valuation Committee of the Missouri, Kansas & Texas Ry., with headquarters at Parsons, Kan. Mr. Dalton succeeds Mr. S. B. Fisher, M. Am.. Soc.. C E., who has been assigned to other duties. Mr. Dalton graduated from the University of Kansas in 1890 and spent practically all of his time in railroad work up to 1904, when he was appointed City Engineer of Lawrence. From 1906 to 1911 he was Professor of Civil Engineering at the University of Kansas and resigned to take the position which he has just given up.

Mr. Ewing D. Sloan, Valuation Engineer of the Nashville, Chattanooga & St. Louis Ry., has been appointed Engineer of Construction of that railroad, which position he will hold in addition to his present duties. Mr. Sloan is a graduate of Washington and Lee University. He has been previously Assistant Engineer of the Virginian Ry., in charge of projected location, and employed in the construction departments of the Minneapolis & St. Louis R.R., Iowa Central lines and the Great Northern Ry. More recently he was made Chief Engineer of the Tuscaloosa Mineral R.R. and then became connected with the Louisville & Nashville R.R. in charge of new construction in eastern Kentucky.

Mr. E. J. Pearson, Vice-President of the Texas & Pacific Ry. at New Orleans, La., has been appointed Vice-President of the New York, New Haven & Hartford R.R., with headquarters in Boston, Mass. He will act as general assistant to President Elliott and will have charge of all matters relating to construction, operation and maintenance. Mr. Pearson graduated from Cornell University in 1883. He has had a large experience in construction and operation, particularly in terminal work. He had entire charge of the construction of the Wisconsin Central Terminal, while in the employ of the Northern Pacific Ry. Later he was for five years in charge of building the Puget Sound extension of the Chicago, Milwaukee & St. Paul Ry. While on a trip East he made a thorough examination of the wharf and dock properties of the New Haven road from New York to Boston, so that he might be able to help in the construction of similar facilities at Duluth and Puget Sound. For four years Mr. Pearson was Vice-President, under B. F. Bush, of the Missouri Pacific System, during which period he did much work in rebuilding and developing the line and in introducing economical operating methods. He has been engaged during the last year on the new terminals of the Texas & Pacific at New Orleans.

OBITUARY

Walter B. Murdoch, an engineer, until recently interested in mining in Mexico, died in New York City, on Mar. 12. He was born in Washington, D. C. For many years Mr. Murdoch had been engaged in building a deep drainage and mining tunnel 12 mi. long, to give access to a chain of gold and silver mines in the districts of Pachuca, Real del Monte and El Chico, State of Hidalgo, Mexico.

Theodore Voorhees, M. Am. Soc. C. E., President of the Philadelphia & Reading Ry., died at his home in Elkins Park, Philadelphia, on Mar. 11. He was born in New York City in 1847 and was a graduate of Columbia College and Rensselaer Polytechnic Institute. He entered the service of the Delaware, Lackawanna & Western R.R. in 1869 and four years later became Superintendent of the Syracuse, Binghamton & New York R.R. Later he was in charge of the transportation department of the Delaware & Hudson Canal Co. and General Superintendent of the New York Central & Hudson River R.R. He became First Vice-President of the Philadelphia & Reading in 1893 and was elected President in 1914, after the death of George F. Baer.

Samuel S. Greeley, a well-known civil engineer and the oldest alumnus of Harvard University, died in Winnetka, Ill., on Mar. 8, at 92 years of age. He was a member of the Harvard Class of 1844 and in the following year entered Rensselaer Polytechnic Institute, graduating from that institution in 1846. He did considerable railway location and construction work in New York, Vermont and Virginia. In 1853 he entered into a land-surveying business with Mr. Hanchett, in Chicago, which was continued until last year, when the firm name was changed to Greeley, Howard & Norlin Co. He was appointed City Surveyor of Chicago in 1855 and served for one term. He obtained a license for the Nicholson Block Paving Co., of Chicago, and laid in that city a considerable amount of the block pavement manufactured by that concern. Later he became interested in the manufacture of threshing machines. In the late 50's Mr. Greeley was appointed Superintendent of the Chicago, Burlington & Quincy R.R., which position he held for a short time In 1879 he took into the firm as partners the late Frederick Greeley, the late Gustav H. Carlson and Sylvester N. Howard, and afterward his son, Morris L. Greeley. He was one of the four organizers, in 1857, of the Harvard Club of Chicago, and was later its President. Mr. Greeley was the grandfather of Samuel A. Greeley, Assoc. M. Am. Soc. C. E., Sanitary Engineer, Chicago.

ENGINEERING SOCIETIES

COMING MEETINGS

AMERICAN RAILWAY ENGINEERING ASSOCIATION.
Mar. 21-23. Annual meeting in Chicago. Secy., E. H. Fritch, 900 So. Michigan Ave., Chicago.

NATIONAL RAILWAY APPLIANCES ASSOCIATION.
Mar. 21-23. Annual meeting in Chicago. Secy., B. V. Crandall, 1824 Lytton Building, Chicago.

ILLINOIS GAS ASSOCIATION.
Mar. 22-23. Annual meeting in Chicago. Secy., H. H. Clark, 136 So. Harvey Ave., Oak Park, Ill.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS.
Apr. 11-14. Spring meeting in New Orleans. Secy., Calvin Rice, 29 W. 39th St., New York City.

AIR BRAKE ASSOCIATION.
May 2-5. Convention in Atlanta. Secy., E. M. Nellis, 53 State St., Boston.

INTERNATIONAL RAILWAY FUEL ASSOCIATION.
May 15-18. Annual meeting in Chicago. Secy., J. G. Crawford, 547 W. Jackson Blvd.

MASTER BOILER MAKERS' ASSOCIATION.
May 23-26. Convention in Cleveland. Secy., H. D. Vought, 95 Liberty St., New York City.

Institute for City Engineers and other public works officials is meeting this week (Mar. 14 to 18) at the University of Kansas, at Lawrence. Of the 20 addresses announced in the program 17 are by professors.

Engineers Society of Western Pennsylvania has elected the following officers for 1916: President, Samuel Lee Duff; vice-president, W. E. Snyder; directors for three years, Wm. E. Mott, Henry D. James. Robert Linton and George Danforth have since been appointed directors to fill vacancies caused by resignation.

Canadian Good Roads Congress—The third Canadian International Good Roads Congress was held at Montreal, Mar. 6 to 10, with an attendance of about 1,000. The sessions were presided over by D. Michaud, Deputy Minister of Roads for Quebec. A number of papers were read at the various sessions by engineers from Canada and the United States, dealing with various features of road construction, and there was an extensive exhibit of road materials and appliances. The new officers elected are: President, J. Duchartel de Montrouge, Outremont; vice-president, F. L. Squire, Toronto; secretary-treasurer, George A. McNamee, Montreal. The meeting a year hence will be held in Winnipeg.

New England Water-Works Association held its regular monthly meeting on Mar. 8 at the Hotel Brunswick, Boston. After the usual luncheon the discussion of the final report of the Committee on Meter Rates, which was not completed at the February meeting, was resumed. A large number of members of the association took part in the discussion, and the report was finally referred back to the committee, with the request that it submit to the association the other method of charging for water which it had under consideration when it recommended the one given in the report. While many members approved of the recommendation of the committee, there seemed to be a general feeling that the matter was one of such importance that the association as a whole should consider it thoroughly before adopting the committee's recommendations. Robert Spurr Weston read a paper on the proposed auxiliary water-supply of the City of Brockton.

Appliances and Materials

New Expansion-Joint Material

A new material for expansion joints in concrete, brick or stone-block paving or in masonry work has recently been marketed by the Barrett Co., New York City, manufacturer of bituminous materials. The new material is a mastic in ribbon form, but without felt or paper reinforcement. It is claimed that a joint made with this ribbon will have all the properties of a poured joint and can be constructed easier, quicker and cheaper. Shipment is made in rolls; various widths and thicknesses are available. The trade name will be "Barrett's Expansion Joint."

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Radical Departure in Electric Wiring

A radical departure (for this country) in house-wiring equipment has been brought out by the General Electric Co., Schenectady, N. Y., in the shape of the so-called "concentric" conductors and fittings. The system has been used abroad to a considerable extent in existing buildings where electric service was desirable, but the ordinary wiring schemes too expensive. The running conductor is 0.22 in. in diameter and consists of a No. 14 solid wire, rubber insulated and single braided; it is jacketed with a closed tinned water- and gas-tight copper sheath (folded longitudinally around the insulated wire and soldered along the lap. The current capacity of the sheath is equal to a No. 12 wire. It serves as the return conductor, is made electrically continuous throughout each installation and is grounded. The wire is supported by small metal clamps.

The fittings are similar in general appearance to the present equipment, but the connections are designed for easy and quick placing. Neat installations are possible without disturbing the walls. There has been a demand for this equipment for small-customer premises; special permission of insurance underwriters has to be obtained for its use.

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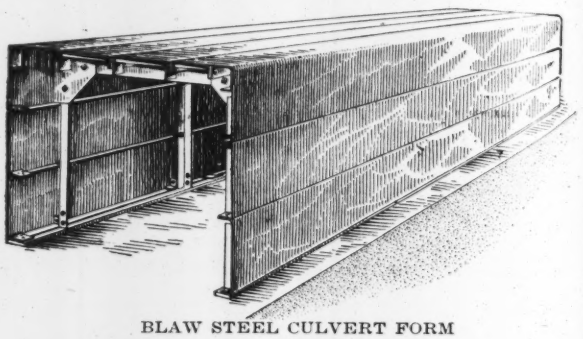
Steel Adjustable Culvert Forms

An adjustable steel rectangular culvert form has been devised by the Blaw Steel Construction Co., Pittsburgh. The construction is shown in the accompanying sketch. The form is composed of plates 12 in. high and has 12x12-in. bracketed corners with brace angles in the interior, which support the sides and roof. A small number of hook bolts are used to connect the roof panels and the side panels to the supporting interior angles through the outstanding flanges of the panels themselves. They draw the entire form together, are very



BLAW STEEL CULVERT FORM

easily inserted in place and are a permanent part of the interior supporting angles. The adjustment is made by either adding or removing a 12-in. side or roof panel. The sections are united by a slip joint quickly operated by hand.

They are in 5- and 10-ft. lengths, and sets are furnished for five lengths, of 25 to 40 ft.; each set is adjustable for culverts from 2x3 ft. to 5x6 ft. Prices run from $220 to $440.

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Efficient Rotary Pump

An interesting gear-type rotary pump has been designed and is being made by the Viking Pump Co., of Cedar Falls, Iowa, the principle of which is shown in the accompanying sketch. There are only three parts—an annular gear, a spur gear and the casing. The annular gear is larger than the spur gear, so that the latter meshes with it by being placed off center; as the spur gear is driven, the annular gear revolves about its own center. A crescent-shaped diaphragm, part of the casing, fills the gap between gear circles caused by offset centers. As the gears revolve, the inter-tooth pockets of the spur gear are filled with water, which is moved past the crescent diaphragm and crowded into the outlet space.

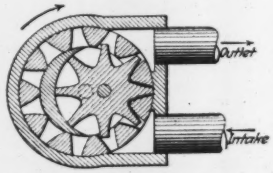

DIAGRAM OF "VIKING" ROTARY PUMP

This pump is made in various small sizes. Tests on a 2-in. pump (suction and outlet) showed efficiencies of 49 to 76% for 45 to 94 gal. per min. under heads of 118 to 100 ft. and at speeds of 215 to 400 r.p.m. A suction vacuum as high as 25 in. of mercury was secured.

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Footwarmer for Watchmen and Policemen

A warming plate, on which watchmen and policemen on fixed-post duty may comfortably stand in cold weather, has been developed by Drew Johnston, of the Duquesne Light Co., Pittsburgh, at the instigation of Councilman Robert Garland and with the coöperation of the Westinghouse Electric and Manufacturing Co. The plate is 18 in. square and contains an 80-watt electric heating element; 10 ft. of armored cable leads to a plug and receptacle, the latter being placed in a special pole box. The name "Tootsietherm" has been applied to the device.